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THE IMPLICATIONS OF PRESIDENT JOHNSON'S MEMORANDA OF SEPTEMBER 13 AND 14, 1965, FOR THE FUNDING OF ACADEMIC RESEARCH BY FEDERAL AGENCIES

PART II

NASA Offices and Research Centers Only

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CHAPTER IV

THE EXPRESSION OF DEMANDS ON THE ACADEMIC RESEARCH FUNDING SYSTEM, 1960-1965

As described in Chapter III, the major research funding agencies have relied on four basic legal-administrative patterns in funding academic research. The President's Memoranda direct the agencies in the future to rely less on the project system and more on grants of an institutional nature. The President's Memoranda reflect four basic demands that have been made on the federal research funding system in the 1960's: (1) the demand for responsibility in the administration of funds; (2) the demand for "equity" in the distribution of funds; (3) the demand for the use of educational criteria in the administration of funds; and (4) the demand for the application of science to social needs.

These demands have been expressed primarily through congressional committees. This section examines the nature and sources of these demands, and the role played by congressional committees in providing a forum for their expression.

The general thesis developed in this section is that in the period 1960-1965 the rationale underlying federal support of academic research gradually shifted from an emphasis on the importance of supporting academic research as a means to the advancement of science *per se*, or for the attainment of a specific agency objective, to an emphasis on the use of federally supported academic research for its educational, economic, and public benefit values.

The Demand for Responsibility in the Administration of Funds

The Nature of the Problem

Although the President's Memoranda do not directly raise the problem, the problem of responsibility in the administration of academic research funds is directly related to the question of the types of programs that agencies should use in funding academic research. The question of responsibility can be summarized as follows.

In the project grant system, funds are obligated by agencies to universities for the funding of research by specified researchers on specified problems. While a grant is nominally made by an agency to a university, control over the expenditure of funds actually vests in most cases in individual researchers. It is unrealistic and probably undesirable for the granting agency to attempt to exercise from Washington close supervision over the expenditure of funds. If supervision is going to be exercised, it must be exercised by the university and individual researchers. Under the project system, however, little if any authority to supervise the expenditure of funds is delegated to the university. The university is primarily a conduit for the transmission of funds from the agency to the researcher or researchers specified in the grant instrument. Don K. Price has expressed this aspect of the problem of responsibility as follows:

> We must find ways to delegate authority and encourage initiative and responsibility in the relation between government and universities. We should be able to do so at least

> as well in this relationship as in state grants-in-aid, where the institution which receives the grants is made more generally responsible for the detailed accountability. But this depends on a proper system of incentives, and that we do not yet have. . . . The problem cannot be solved by detailed bookkeeping requirements. It can only be solved by a system which gives the university an incentive to take the same point of view as that required by the higher interests of government policy. And this is of course the most powerful argument for moving, at least in part, from a system which bases support for research on a series of small narrowly defined projects to a system of broader general grants--to the "program project" or the institutional grant.[1]

The intensity of concern over the question of responsibility in the administration of academic research funds was expressed by Dael Wolfle, the publisher of _Science_, in an editorial published in the October 14, 1966 issue of _Science_.[2] Wolfle pointed out that when the federal grant program started, the honesty and good sense of scientists were expected to control the ways in which money is used. However, as the federal academic research enterprise has expanded, informal surveillance by professional colleagues and academic research administrators has no longer seemed to provide adequate controls. The

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[1] Price, "Federal Money and University Research," _Science_, CLI, 288.

[2] Dael Wolfle, "Academic Responsibility," _Science_, CLIV, No. 3746 (October 14, 1966), 219.

result has been a tendency in some agencies to impose more and more bookkeeping requirements on researchers and research administrators.

Most agencies, however, have argued that control should be primarily a voluntary and institutional responsibility, rather than a direct governmental responsibility. Furthermore,

> University presidents have generally understood the importance of keeping control at the institutional level. But scientists often have not, and some have failed to recognize the need that there be public confidence that public funds are used prudently and honorably. They have talked much of academic freedom without accepting the correlative requirement of academic responsibility. Sooner or later there is going to be a messy public scandal.[1]

Whether Wolfle is right in his assertions or not, it is clear that the question of responsibility is one that has not yet been resolved. The prospects for the resolution of this question will be analyzed through an examination of the way in which the question has arisen and the positions of the various parties that have become involved with the question. Ideally, it would be possible to summarize the position of the "scientific community," of the

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[1] Ibid.

"academic community," of Congress, and of the federal agencies as a whole. Such a summary is difficult because no single position has been taken by all the members of each of these groups. Congress, for purposes of analyzing this question, must be viewed as a set of committees rather than as a single body. It simply is not possible to ascribe a single position on this question to Congress as a whole. The same is true for the other groups involved. The best that can be done is to describe how the question has been raised, and note the positions taken by the immediate parties involved.

The Development of the Issue of Responsibility

At the heart of the question of responsibility in the administration of academic research funds is the question of the terms and conditions under which public funds should be allocated to private performers, investigators in universities, in the pursuit of public purposes as defined by statute and administrative processes. Two conflicting answers to this question have evolved since the late 1950's. The first position is that federal funds for academic research should be granted to investigators in the form of conditional gifts which give investigators the maximum freedom in pursuing lines of research, because the advancement of basic science _in itself_ is in the national interest. Agency supervision and bookkeeping and reporting requirements should be kept to a minimum because such requirements tend to interfere with creative research. In this argument, government is cast in the role of a patron of science.

The second position is that federal funds for academic research should be granted to investigators only when adequate safeguards are imposed to ensure that the funds are in fact being spent for the specific purpose approved by the agency. In the case of federal grants for research, as in the case of federal grants for other purposes, agencies should exercise close supervision over the expenditure of funds, and should impose tight bookkeeping and accounting requirements. In this argument, grants for research, whatever they are called, constitute a special type of contract in which the government is cast in the role of a purchaser of research services. Like any other contractor, the government is entitled to the performance bargained for and should take steps to determine that in fact it is receiving that performance.

The conflict between these two points of view probably is inherent in the project-grant method of funding research. In the early days of the project-grant system the President's Scientific Research Board in its August 27, 1947 Report defined a research grant as "a gift made to individuals or institutions whose competence has been demonstrated for the purpose of an investigation, whose outcome cannot be known precisely in advance."[1] Other analysts have argued that a research grant is not a form of gift, but a form of contract.[2]

The differences between these two points of view are not merely semantical or legalistic in a narrow sense. These differences have proven to be a source of intense political conflict over the purpose of the support of academic research

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[1]U.S. President's Scientific Research Board, _Science and Public Policy_ (Washington: U.S. Government Printing Office, 1947), Vol. I, p. 50.

[2]See, e.g., Matthew J. Travers and Robert Sheriffs Moss, "Research Grants and Contracts of National Institutes of Health, A Study," in U.S. Congress, House, Select Committee on Government Research, _Contract Policies and Procedures for Research and Development_, 88th Cong., 2d Sess., 1964, pp. 99-118.

by federal agencies, and have had a substantial impact on the day-to-day administration of project grants.

The differences between these two positions first attained political importance as a result of investigations undertaken in 1959 of NIH by the House Intergovernmental Relations Subcommittee of the Committee on Government Operations headed by Representative Fountain of North Carolina. Up to 1959 no major congressional committee had conducted a careful examination of the administration of academic research grants by a major agency. Congressional control of agency research practices was exercised primarily through the appropriations process. Writing in 1959, Charles V. Kidd asserted that:

> The appropriations process, rather than substantive legislation or investigation, is the means by which Congress exerts the most continuing and direct control over the research and development programs of federal agencies.[1]

In the same year that this statement was written, the Fountain Committee began its investigations of NIH. As is described in this chapter, from 1960 to 1965 a

[1] Kidd, American Universities and Federal Research, p. 10.

number of other investigating committees systematically conducted investigations of the research programs of various agencies, and provided forums for the expression of demands that in part are reflected in the content of the President's Memoranda. By focusing public attention on federal research programs, these investigating committees have exercised to an indeterminate extent a measure of control over these programs.

In 1961 the Fountain Committee released the first report on its investigations of NIH.[1] While the report covered a number of topics, a substantial part of the report concerned the financial aspects of the management of NIH grants. The committee found that,

> Over the years NIH has, in general, eased requirements to afford the grantee greater flexibility and independent judgment in handling research funds. Although applicants are required to present a fairly detailed description of their budget needs, grantees are permitted almost complete discretion in determining the use of the money once awarded.[2]

The committee found that in the period 1956-1960, NIH

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[1]U.S. Congress, House, Committee on Government Operations, _Health Research and Training: The Administration of Grants and Awards by the National Institutes of Health_, Report of the Intergovernmental Relations Subcommittee, 87th Cong., 1st Sess., 1961.

[2]_Ibid._, p. 36.

consistently allowed successful applicants about 95 percent of the total research funds they requested, and that NIH exercised little if any control over the way funds were spent once a grant had been made. The committee asserted that,

> In the course of its investigation, the committee found disturbing evidence of the kinds of financial abuses that can and do occur without detection under existing administrative arrangements.[1]

The committee gave several examples of what it termed deficiencies in NIH's management of grants, and set forth a series of recommendations for the improvement of NIH grant procedures.

Like the other major research funding agencies, NIH was not accustomed to dealing with criticisms of its administration of research funds by investigating agencies. Because of this, NIH did not respond to the recommendations made by the Fountain Committee. In a news report written in 1963, Science quoted an NIH official as stating that,

> Fountain is right that nothing was done after the first report. At that time, we had no comprehension of the seriousness of the matter.

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[1] Ibid., p. 39.

> We had differences among ourselves as to what should be done, and as a result, we did nothing. Some people felt that no changes were needed, and there was a feeling that time would pass and the whole thing would be forgotten.[1]

Following the release of its first report in April 1961, the committee with the assistance of the General Accounting Office made an audit of NIH grants to Public Service Research, Inc., of Stamford, Connecticut. This corporation was created in 1959 for the purpose of conducting research in health, education, welfare, and related fields.

From July 3, 1959, the date of its creation, to December 31, 1961, the cut-off date of the audit, Public Service Research, Inc., received $445,161 in income, of which $426,601, or about 96 percent, came from federal agencies, and $378,596, or 85 percent, from NIH grants. Among other things, the Fountain Committee audit revealed: (1) that salary costs were improperly charged to NIH grants for time spent by corporate officers in business pursuits unrelated to the conduct of research; (2) that salary costs were charged to various grants for time spent by a corporate

[1] Daniel S. Greenberg, "NIH and Fountain," Science, CXL, No. 3571 (June 7, 1963), 1076.

officer as a consultant to NIH, for which he was also paid $50 a day plus travel expenses; (3) that travel expenses were charged to grants in several instances in which the travel had little or no relationship to the grant charged; (4) that in several instances entertainment expenses were improperly charged to NIH grants; (5) that the corporation received in overhead payments an amount in excess of the actual costs incurred; (6) that various expense items in many cases were incorrectly classified as direct costs of particular grant projects, and (7) that the corporation claimed a depreciation allowance in its federal income tax returns for equipment purchased from NIH funds.

On March 28, 29 and 30, 1962, the Fountain Committee held additional hearings "to learn further what steps have been taken and the progress made by the National Institutes of Health in implementing recommendations made by our full Committee on Government Operations in House Report No. 321, issued in April of 1961,"[1] and to inquire about the audit of Public Service Research, Inc. Fundamental disagreements between NIH and the committee over project grants emerged

[1] U.S. Congress, House, Committee on Government Operations, _The Administration of Grants by the National Institutes of Health_, Hearings before the Intergovernmental Relations Subcommittee, 87th Cong., 2d Sess., 1962, p. 1.

in these hearings. The basic question in issue was the nature and purpose of the project grant. While in these hearings the issue arose in the context of an examination of NIH grants, the issue involves project grants made by all federal agencies.

On the first day of the hearings, March 28, 1962, the Director of NIH, James A. Shannon, explained NIH's position on the purpose of project grants and on the question of responsibility for the administration of project grant funds. In essence, he argued that administration is fundamentally a means to an end. Every aspect of administration should be judged by its effect on the attainment of substantive goals. The basic goal of NIH is to further medical research in the United States. The effectiveness of NIH grant programs cannot be measured solely in terms of the volume of money expended for research. The effectiveness must also be measured by the terms and conditions of grants relied on by NIH to encourage research productivity. The terms and conditions of NIH grants are based on several fundamental premises. First, project grants depend on the initiative of scientists in proposing research to be supported. Project grants are supported by NIH in response to the internal logic of science, which rests on a continuing evaluation of research efforts by the collective efforts of members of the scientific community. The organizational structures and procedures of NIH are designed to give expression to the autonomy and internal workings of the scientific community concerned with medical research.

> Investigators in this situation are not conducting research for NIH. They are exploring ideas of their own choosing . . . the objectives sought by these investigators are those that are exactly the same as goals constituting a major share of the mission of the National Institutes of Health.[1]

Second, under the project system, investigators are free to plan and conduct both the substance and the financial aspects of their investigations as they think best. Investigators are allowed to shift the emphasis in their investigations, and within broad limits to shift funds from one broad category to another.

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[1] *Ibid.*, p. 13.

> This grant of freedom to the investigator is deliberate and in response to a fundamental philosophy. It is not a consequence of inability to place tight controls over the expenditure of funds. The basic component of this philosophy is that science will advance most rapidly, and that as a consequence, practical findings will emerge most rapidly and in the greatest profusion, if science is unfettered by restrictions--if scientists are given freedom to follow their ideas.[1]

Third, grantees are selected by their peers, who evaluate both the man and the merit of his research proposal.

> This is the point at which the really significant administrative actions designed to make the program efficient and productive are taken. Selection of good men and good ideas--and rejection of the inferior--is the key. All subsequent administrative actions having to do with the adjustments of budgets, and so forth, are essentially trivial in relation to this basic selection process.[2]

Shannon then set forth NIH's position on the legal status of project grants. He asserted that:

> The research grant is, in essence, a trust. . . . Once the award is made, the use of granted funds is left to the investigator and the institution. They are accountable for exercising the trusteeship responsibility. This is in marked contrast with the essential idea of a contract, which

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[1] Ibid.

[2] Ibid., p. 14.

> is a promise by a contractee to deliver a predetermined product to a contractor for a predetermined price.[1]

Shannon admitted that in practice the distinctions between grants and contracts are often ignored, but he asserted that:

> The essential difference exists. A grant is a trust which makes the effective expenditure of funds the responsibility of the recipient. A contract is for specific performance--production of something for the contractor for a price and under terms set by the contractor.[2]

Finally, Shannon asserted that the committee in its investigations was striking at the heart of the project system and threatening to impair the working of the system because of the committee's failure to distinguish between contracts and trusts:

> Mr. Chairman, it has been my observation that many of the committee's inquiries seemed to rest implicitly upon the assumption that we are--or should be--operating a research contract and not a research grant system. We deliberately do not do many things which are necessary and proper under a contract system.[3]

The difference between a grant and a contract, Shannon

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[1] Ibid., p. 15. [2] Ibid. [3] Ibid.

asserted, is this:

> I think a grant is a gift given to an individual in support of some general activity that is felt to be desirable by the granting agency. I think a contract in general is for the purchase of some specifiable, identifiable object. Now, there are all kinds of differences and modifications in practice, but these are the two basic differences.[1]

Later in the hearings in response to intensive questioning about the detailed mechanics used by NIH to assure that its project grants are responsibly administered, Shannon bitterly asserted that:

> I am not a neophyte in science. And I think I know something about the mechanics of science. I think I know something about the mores of institutions within which science operates. And I do not think that an auditor, or somebody that approaches it from the standpoint you are, has any conception of what constitutes the environment of an academic institution. And I think you are making some very damaging statements that are ridiculous.[2]

Throughout the hearings the committee challenged the interpretation of project grants expounded by Shannon, particularly through detailed questioning concerning the audit of Public Service Research, Inc. In its report

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[1] _Ibid_., p. 79.

[2] _Ibid_., p. 82.

based on the hearings,[1] issued on June 30, 1962, the committee took direct issue with the interpretation of project grants expounded by Shannon. After quoting Shannon's assertion that a project grant is a trust which makes the effective expenditure of funds the responsibility of the recipient, the committee asserted:

> The committee cannot accept the NIH view that administrative actions for the effective and economical expenditure of grant funds are "trivial" or are matters of little importance. Nor can the committee agree that the choice of the grant rather than the contract as the device for supporting research relieves NIH of normal responsibility for the proper and prudent expenditure of Government funds. While the manner of obtaining accountability and the required degree of adherence to the research plan may differ under a grant and a contract, the committee believes that a Government agency is equally responsible for the proper, efficient, and economical use of public funds irrespective of the final instrument employed.[2]

The committee asserted that it is fully committed to the principle of allowing grantees the greatest possible freedom in the conduct of research. However, it argued that in the case of grants by NIH, freedom had become confused

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[1] U.S. Congress, House, Committee on Government Operations, _Administration of Grants by the National Institutes of Health_, Report of the Intergovernmental Relations Subcommittee, 87th Cong., 2d Sess., 1962.

[2] _Ibid_., p. 15.

with fiscal irresponsibility.

> It is apparent to the committee that many scientists regard their grants as personal resources and use surplus funds that remain after providing for necessary project expenses for nonessential purposes, rather than return surplus money to the Government. . . . There is also a tendency for institutions to permit project grants to be spent less carefully than the institution's own funds. Since the grant is awarded for use under the direction of a particular investigator selected by NIH, the institution often tends to regard itself as only the "host" for the project and does not exercise the same degree of management responsibility as for the research which it sponsors. . . . The committee recommends, accordingly, that NIH formulate grant principles which will clarify the moral obligations of the scientist as a trustee of public funds. The committee recommends that NIH develop administrative arrangements for obtaining greater responsibility on the part of grantee institutions for the prudent expenditure of project funds.[1]

Finally, the Fountain Committee criticized the Appropriations committees and the rest of Congress for appropriating more money to NIH than the agency was capable of administering effectively.

NIH responded to the criticisms of the Fountain Committee by announcing new regulations for the administration

[1] *Ibid.*, pp. 24-25.

of grants in October 1962, and by issuing the _Public Health Service Grants Manual_ in January 1963.[1] The _Manual_ reaffirmed NIH's position that a grant is legally a conditional gift that creates a relationship of trust between the granting agency and the grantee. The _Manual_ asserted that the grant creates a special relationship among the agency, the investigator, and his institution, a relationship that arises from the basic nature of the grant as a conditional gift in response to a request for support of a venture in which there is a substantial measure of public interest. The _Manual_ further asserted that this is a relationship of trust which imposes upon the grantee the responsibility: (1) to assure that the grant funds are utilized for the purpose for which they were given; (2) to exercise the same probity and prudence in their expenditure that is extended to the use of the grantee institution's own funds.

The Fountain Committee's criticisms of NIH and NIH's reactions to these criticisms provoked great concern among scientists over the legal and administrative relationship among agencies, investigators, and universities.

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[1] Department of Health, Education, and Welfare Public Health Service, _Public Health Service Grants Manual_ (Washington: Public Health Service, 1963).

This concern was expressed by the American Society of Biological Chemists in a resolution adopted at its annual meeting in April 1963. This resolution urged the National Academy of Sciences to formulate an authoritative expression of the position of the scientific community on the basic principles that should be relied on in the administration of federal research grants. The resolution asserted, in part:

> The necessity for closer definition of the relationships involved has been brought into focus by the criticisms recently directed by the Intergovernmental Relations Subcommittee of the House Committee on Government Operations against the management of the research grants program of the United States Public Health Service. While regretting the manner of criticism of the House Committee and their failure to provide constructive leadership, we suggest that the time is indeed opportune and the moment critical for appraisal of the relationships which properly should obtain among the federal government, universities, and scientific investigators if the national interest is to be served.[1]

In response to this resolution, and similar resolutions passed by other scientific societies, the National Academy of Sciences voted at its annual meeting in 1963 to undertake an examination of the fundamental principles

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[1] Elinor Langer, "Federal Grant Policy," Science, CXL, No. 3568 (May 17, 1963), 795.

on which agency-university-investigator research relationships are based. The study, which was conducted with the financial support of the Ford Foundation, was undertaken by the Academy's Committee on Science and Public Policy, headed by George Kistiakowsky of Harvard. The committee's report, _Federal Support of Basic Research in Institutions of Higher Learning_,[1] constitutes the closest statement available of a definitive expression of the position of "the scientific community" on the question of the principles on which federal support of academic research should be based. This report must be considered in the political context in which it was issued.[2]

While the Fountain Committee was conducting its investigations of NIH, in 1962 the National Science Foundation revealed that it was demanding reimbursement

[1] National Academy of Sciences, Committee on Science and Public Policy, _Federal Support of Basic Research in Institutions of Higher Learning_.

[2] For reports on the climate in Congress in 1963 as it affected academic science, see Kenneth Kofmehl, "Science and Congress," in National Institutes of Health, _Fourth Seminar on Science and Public Policy for Senior Extramural Staff_ (Washington: National Institutes of Health, 1966), pp. 96-117. For a commentary on the role of the committee on Science and Public Policy (COSPUP) in the formulation of national science policy, see Kenneth Kofmehl, "COSPUP, Congress, and Scientific Advice," _Journal of Politics_, XXVIII (1966), pp. 100-120.

from the American Institute of Biological Sciences (AIBS) of funds that AIBS had spent for purposes other than those authorized by NSF-AIBS grant instruments. While Congress was not directly involved in the AIBS case, the case drew attention to possibilities of the mismanagement of grant funds. Partly as the result of the AIBS case, NSF in June 1963, issued a revised version of its administrative guide, Grants for Scientific Research. The revisions, which were based on extensive consultation with scientific groups and university administrators, were designed to emphasize that universities and investigators bear important responsibilities for the prudent administration of grant funds.

Direct congressional interest in the administration of federal research programs was expressed in a number of other ways. On September 11, 1963, the House established a Select Committee on Government Research to examine federal research programs. Representative Carl Elliott of Alabama who faced a difficult election contest that he subsequently lost, was appointed chairman of the committee. This action of the House was interpreted by some commentators as indicating that the investigation of federal research programs was becoming an important way for congressmen to attain political visibility and importance.[1] In October 1963, the House Science and Astronautics Committee created a ten-man Subcommittee on Science, Research, and Development. Representative Emilio Q. Daddario of Connecticut was named chairman. The subcommittee was created to make general evaluations of federal research programs, and to strengthen congressional access to scientific and technological information. Creation of this subcommittee was regarded as further evidence of the interest in Congress in restoring legislative control of the research budget.[2]

In a similar vein, the House Committee on Armed Services in 1963 created a Subcommittee on Military Record and Development, of which Representative Melvin Price was appointed chairman. In addition, the report of the Special Subcommittee on Education of the House Committee on

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[1] Daniel S. Greenberg, "Investigation: House Unanimously Approves Comprehensive Inquiry Into Federal Support of Research," Science, CXLI (September 20, 1963), 1161.

[2] John Walsh, "New Overseers for Federal Science," Science, CXLII (October 11, 1963), 210.

Education and Labor, The Federal Government and Education, was issued in June 1963. This report constituted the most extensive effort of a congressional committee up to that time to systematically organize and analyze information on the Federal Government's involvement with education, including research relationships between agencies and university investigators. In related inquiries, the National Academy of Sciences in February 1963, created its Committee on Science and Public Policy, while the report of a study sponsored by the Carnegie Foundation, "Twenty-Six Campuses and the Federal Government," was released in April 1963.[1] This study focused on both the problems and the opportunities posed by the extensive involvement of universities with federal research.

These various activities directed attention to a number of specific problems inherent in agency-university research relationships, such as the problem of interest on federal grants balances, patent policies, faculty compensation through grants, and indirect cost limitations. Underlying the concern over these specific issues, however, was

[1]See The Educational Record, XLIV, No. 2 (April, 1963), 95.

a growing realization that the federal government is involved with higher education through research programs in a massive way. Charles Kidd had noted in 1958 that:

> Since the role of the federal government in supporting higher education is traditionally a subject for heated debate, it is remarkable that the significant Federal payments to higher education derived from research funds have not been more vigorously argued. The discussion has been muted because the support has been piecemeal, dispersed among a number of Federal agencies, and a by-product of the less debatable function of aiding research.[1]

Judged in terms of congressional and public concern, 1963 represents a turning point in agency-university relationship.

In the context of this concern, the National Academy of Sciences released its report by the Committee on Science and Public Policy, Federal Support of Basic Research in Institutions of Higher Learning. The report is significant because it constitutes an attempt by a prestigious and influential group of scientists to express in a definite way a consensual position in the scientific community on what the terms and conditions of federal support of research should be. While the "scientific

[1]Kidd, American Universities and Federal Research, p. 228.

community" is in part a highly pluralistic and diversified one,[1] the Committee on Science and Public Policy attempted to express support of the project system on the part of scientists who were becoming increasingly concerned over proposals to modify the system to accommodate demands for more responsibility in the administration of funds, greater institutional support, and wider geographical distribution of funds.

The report asserted that since World War II, American science has reached a position of world leadership largely because of the enlightened policies of several federal agencies committed to the furtherance of basic research through project grants and the use of advisory scientific bodies to select scientifically meritorious projects for support. The committee asserted in the strongest terms its conviction that the project system should be retained on the primary basis of federal support.

> The use of the project is consistent with our belief that the investigator's ability and creativity is the crucial ingredient in all research. The project proposal is an important index of the investigator's ability and creativity. . . . Through the project system the

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[1]See, e.g., Wallace D. Sayre, "Scientists and American Science Policy," Scientists and National Policy Making, ed. Robert Gilpin and Christopher Wright (New York: Columbia University Press, 1964), p. 97.

> federal government can finance research in institutions of higher learning in the way that relates the award of funds as closely as possible to scientific merit and minimizes the effects of political pressure. There is no way for the federal government to make general grants to universities with unspecified purpose, on the basis of merit, without undertaking to rate or accredit the universities, either as a whole or with respect to the quality of their scientific programs.[1]

Consistently with these general principles, the committee recommended: (1) that scientific merit, as judged by scientists, should be retained as the primary criterion for federal support of academic research; (2) that agencies not using advisory groups of scientists to judge the merit of proposals should do so; (3) that the trend towards imposition of detailed reporting requirement, provoked in part by the Fountain Committee, should be reversed; (4) that principal investigators should be given maximum latitude in spending grant moneys for the attainment of the general purpose stated in the grant application, except in the categories of compensation of senior personnel, travel, and improvements in the facilities of the grantee institution; (5) that requirements

[1]National Academy of Sciences, Committee on Science and Public Policy, _Federal Support of Basic Research in Institutions of Higher Learning_, pp. 76-77.

for accounting by researcher for time spent on research should be abolished, and that accounting for effort devoted to research should be made in terms of a fraction of the total effort applied by the individual to his university duties; (6) that university administrators should attempt to provide a clear definition of the mutual responibilities and authority of university administrators and investigators under grants; and (7) that investigators should recognize that grants are trusts rather than gifts, and should not spend grant money for purposes unrelated to the grant. The committee further recommended that in addition to project grants, three auxiliary types of support should be used to ensure the healthy growth of American sciences: institutional grants to offset imbalances created in universities by projects grants, small research grants for junior faculty members, and developmental grants for weak institutions. In the context of the total report, however, the committee's recommendations for auxiliary forms of support received very little attention in comparison to the attention given to the committee's support of the project system.

<u>Federal Support of Basic Research in Institutions of Higher Learning</u> is a classic statement of the principles judged by orthodox members of the scientific community to be fundamental to the relationships between federal agencies and university researchers. It is highly ideological in nature, in the sense that it is primarily concerned with the promotion of the interests of scientists rather than the interests of federal agencies or of universities. Its basic argument is that the interests of agencies, universities, and others, will best be served if the interests and needs of investigators are satisfied first. The basic needs of scientists are to receive funds on the basis of evaluation of their ideas and records by other scientists, and to secure funds under terms and conditions that provide them with maximum freedom in the performance of their work, subject to the provision that expenditures of public funds must be accounted for at least in a general way. While recognizing the desirability of general purpose grants to institutions and a wider geographical

distribution of funds, the report strongly opposes any general shift in federal policies away from projects awarded on the basis of merit towards general grants awarded on a basis of institutional or geographical need. The tacit assumption on which the report is based is that what is good for science and scientists is good for the country in general, and federal agencies and universities in particular. By emphasizing continued reliance on the project system and merit criteria, the report tacitly disapproves of efforts to award funds to achieve other social and economic ends, such as a general strengthening of the capacities of universities to control their own developments. Finally, the report does not support the argument that greater institutional responsibility in the administration of funds could be attained by providing universities with incentives towards better management in the form of general funds. While generally favoring the exercise of institutional responsibility, the report is silent on the question of how the exercise of responsibility might be achieved.

As a result of the criticisms of NIH made by the Fountain Committee in 1962 and 1963, President Kennedy in the summer of 1963 directed the Office of Science and Technology to undertake a study of NIH's organization and procedures. The Office of Science and Technology appointed an NIH Study Committee of thirteen prominent scientists and university and business administrators. The Study Committee in turn recruited an advisory staff of around one hundred administrators and scientists. The report of the subsequent investigation, _Biomedical Science and Its Administration_,[1] was released in February 1965.

The full committee report and eleven supplementary panel reports constitute a thorough study of NIH's policies and procedures. The Administration Panel directed itself explicitly to an analysis of the relations among investigators, institutions, and NIH. Like others who have examined these relationships as they exist in the project

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[1]_Biomedical Science and Its Administration_ (Washington: U.S. Government Printing Office, 1965). For a caustic criticism of this Report on the grounds that it was prepared by men who are direct beneficiaries of the policies and procedures under scrutiny, see Joseph D. Cooper, "Onward the Management of Science: The Woolridge Report," _Science_, CXLVIII (June 11, 1965), 1433-1439. See also, Daniel S. Greenberg, "NIH Study: Woolridge Committee Praises Past Efforts But Urges Major Organizational Revisions," _Science_, CLI (March 26, 1966), 1556.

system, the Panel concluded that "the institution's interests and concerns are largely ignored." Despite this, the Panel strongly emphasized that the university is essential to the effective administration of project grants. It asserted that the concept of responsibility has little meaning unless it is analyzed in the context of the relationship between an investigator and his institution.

> NIH . . . must, like any other Executive agency of the Federal Government, respond effectively and promptly to reasonable questions from the Congress about its use of appropriated funds; on the other hand, for a few hundred people in Bethesda to keep track of the activities of 50,000 investigators in 1,500 places . . . with no intermediate level of supervision, is clearly an administrative impossibility. . . . In fact, on a day-to-day and local basis, and presumably varying in effectiveness from place to place, supervision does occur. The daily conduct of the investigator and the progress of his work are substantially influenced by whatever climate, intellectual and administrative, his local institution affords. Other than this local climate and the local rules and *mores* that embody it, NIH simply has no effective or suitable means for enforcing upon an investigator any desired pattern of daily behavior. . . . NIH, if asked to justify its confidence that a particular investigator is a dependable and competent man, will usually have to cite as major evidence the fact that he is a respected member of the faculty of a respectable, well-run institution. In short,

> the institutions already play a vital role in the supervisory function which is one of the general management duties NIH cannot escape. Our suggestion is that this role of intermediate supervision be explicitly recognized and strengthened.[1]

The Panel reported it had found that investigators have become accustomed to dealing directly with NIH personnel, and only incidentally, if at all, with university administrators. This pattern of direct relationships between investigators and NIH has led many investigators to exercise, in matters of grantsmanship and administration, entrepreneural talents that might better be channeled into the conduct of research. The Panel found that many investigators seemed to regard improvement of the institution as a problem for Deans, rather than as a joint enterprise between faculty and administrations. Investigators tend to become preoccupied with the establishment and maintenance of their own little empires.

> The present practice tends to suggest that the investigator is an entrepreneur who can, and in prudence should, continually threaten to move his enterprise to other quarters if his present landlord is ever in any way at fault.[2]

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[1] Biomedical Science and Its Administration, pp. 99-100.

[2] Ibid., p. 102.

The Administration Panel made three specific recommendations for strengthening the supervisory role of universities. One, the practice of calculating an indirect expense allowance for each proposal and making an individual award which includes the indirect allowance should be abandoned. The effect of this practice is to create the impression in the mind of the investigator that the institution is taking money intended for the direct support of his research and directing the money to its own use. The Panel noted that although investigators generally understand that their research requires expenditures by the institution for indirect costs such as heat and light, investigators tend to believe that they in fact are doing the institution a favor by securing a grant, and have difficulty in recognizing the legitimacy of the interest of the institution in a part of the funds. The committee recommended a clear administrative separation of the handling indirect from direct costs, and the development of a direct relationship between the agency and the institution for separate payment of indirect costs. Two, the Panel recommended abandonment of the practice of including some or all of the pay of the investigator as an item of direct project expense.

> The investigator's own pay is, to him, different in kind from any other item of expense in the total budget of his project. It has emotional significance: it is a symbol of his "belonging," in some sense, to whatever organization provides the pay.[1]

The Panel recommended that all negotiations over the pay of investigators be handled by university administrators and NIH personnel, and that all reimbursements for pay of investigators be assigned to a general pool from which salary payments are made. Three, the Panel criticized the practice of revealing the pay of investigators to the scientists reviewing the technical merit of proposals, stating that a scrupulous respect for the relations between investigator and institution calls for administrative privacy on this matter. In addition, the Panel recommended a specific set of administrative procedures to implement its substantive recommendations. The investigator should submit an initial proposal, setting forth the items of expense that he will be

[1] _Ibid_.

responsible for, and stating the fraction of his total professional time he intends to spend on the project. The institution should then formulate an additional proposal, setting forth all other expenses of the projects, such as the investigator's pay and the indirect expenses of the project. The study section should then be given only an approximate idea of the cost of the proposed project. If NIH decides to make a grant, final negotiations on the terms of the grant should be conducted between NIH and the institution, without participation of the investigator or a study section. Finally, the notice of award should be sent directly to the institution, rather than to the investigator. The institution should then make all necessary further arrangement with the investigator concerning the investigator's obligations to the institution.

The Panel recognized that NIH since 1963 has been experimenting with methods to strengthen the supervisory role of institutions, and recommended that NIH substantially increase its general research support grants as an incentive to the institutions to strengthen their own supervisory activities.

The full committee elaborated somewhat on the Administration Panel's recommendations. The full committee strongly endorsed the Administration Panel's recommendations that the supervisory role of the grantee institution be strengthened, but also pointed out that many institutions are not well prepared for this task. The committee reported its finding that many institutions display serious administrative weaknesses. Institutions frequently impose more onerous restrictions on investigators than are required by agency regulations. In many cases institutions fail to provide investigators with information and assistance on the preparation of proposals and accounting reports, refuse to make relatively simple inexpensive facility and other arrangements, place unreasonable restrictions on the acquisition of necessary equipment and supplies, and otherwise fail to provide an environment suitable for the conduct of research.

> Such weaknesses have an important effect on the morale and productivity of the research scientists, as well as on the ability of the institution to fulfill the leadership role that society requires of it. Where major administrative weaknesses exist, they need to be corrected before NIH passes to institutional management the additional responsibilities that we feel the long-range situation requires.[1]

In discussing the incapacities of many institutions to manage research funds in what it deemed to be an effective and responsible manner, the Woolridge Committee explicitly admitted that it was recommending action by NIH that might have the effect of increasing the control of the agency over certain facets of an institution's operations.

> We are aware that we are here recommending what may appear to be an increase in the amount of "control" exercised by NIH over the universities. We make such a recommendation despite our conviction that the Government should employ great caution in intervening in the processes determining the course of development of our institutions of basic science and higher learning. But we are dealing with an actual, not an ideal, situation.[2]

There is no simple way by which the committee's allegations of administrative weaknesses can be tested,

[1] *Ibid.*, p. 31.

[2] *Ibid.*, pp. 31-32.

nor is it possible to state with any certainty what the view of "the educational community" is on this question. The number and diversity of institutions of higher education in the United States makes generalization difficult. Two facts are clear. The first is that <u>formal</u> relationships between agency personnel and institutional representatives, as institutional representatives, are minimal. At present, there are few if any regular and systematic ways in which agency representatives and institutional representatives meet on neutral grounds to discuss and examine agency-university problems. The general effect of this situation seems to be to maximize the importance of informal contacts between agency personnel and university representatives, and membership on the advisory boards that permeate federal agencies. The second fact is that there are many different types and sizes of institutions of higher education. These institutions do not have any common spokesman to represent the interests of institutions of higher education as such before Congress or the agencies.

Homer D. Babbidge, Jr., has observed:

> I am very much afraid that American higher education . . . is in danger of dissipating its energies and losing control of its future, as a consequence of fragmentation; of becoming an assemblage of particular interests rather than a cohesive force for the development of sound national policies. To what extent this tendency can be blamed on federal involvement itself, is hard to say.[1]

This fragmentation is reflected in the specialized associations that represent special interests in higher education, such as the Association of State Universities and Land Grant Colleges, the Association of Medical Colleges, and the Association of Schools of Public Health.[2]

The American Council on Education is the only comprehensive organization in higher education. Its membership is composed of national and regional educational associations, and a majority of institutions of higher education in the United States. The Council, through its Commission on Federal Relations and Committee on Sponsored Research, continually re-examines the administration of federal research grants and attempts

[1]Homer D. Babbidge, Jr., "Scientist Affluent, Humanist Militant," Graduate Journal, V (1962 Supplement), 158.

[2]For a complete listing of associations, see U.S. Department of Health, Education, and Welfare, Office of Education, Education Directory, Part 4, Education Associations, 1965-1966.

to formulate general principles relevant to agency-university relationships.[1]

Because of the great diversity among educational institutions, however, and the varieties of administrative organizations and procedures they use to administer research funds,[2] the Council has not attempted to prescribe any single organizational or procedural pattern that should be followed by all institutions. The Council's efforts have been directed primarily to the stimulation of discussion and analysis of federal programs,[3] and the assessment of trends in the development and administration of these programs.[4]

As a result of its concern over the meaning of responsibility in the administration of federal academic research programs, the Council's Commission on Federal Relations decided in the spring of 1966 to invite

[1] See, e.g., the statement of Logan Wilson, President, American Council on Education, in House, Committee on Science and Astronautics, Distribution of Federal Research Funds . . . , p. 457.

[2] See William C. Wheadon, "Organizing University Research," Industrial Research, VI, No. 4 (1964), 38.

[3] See, e.g., Charles G. Dobbins (ed.), Higher Education and the Federal Government (Washington: American Council on Education, 1962).

[4] See John F. Morse (Director, Commission on Federal Relations, American Council on Education), "The Federal Government and Higher Education, General and Specific Concerns in the Years Ahead," The Educational Record (Fall, 1966).

prominent agency and university research administrators to contribute to a manual on university administration of federal grants. This manual, which is intended to give concrete definition to the meaning of "responsibility" in research grant administration, is scheduled for publication in early 1967. It is questionable, however, whether such efforts can successfully meet the apparent need for regular systematic exploration of mutual problems by university and agency personnel, as well as by university and congressional personnel.

In response to congressional and other expressions of concern over the administration of federal academic research programs, the Bureau of the Budget in 1964 undertook its own study of these programs. The Bureau's report[1] noted the fundamental ambiguity inherent in the idea of a research grant, and called for the abandonment of the use of the grant and the substitution of a simple research agreement, designed to emphasize the mutual obligations between agencies and the universities. While the Bureau's Report is not binding on all agencies in a definitive,

[1]Bureau of the Budget, The Administration of Government Supported Research at Universities (Washington: Executive Office of the President, 1966). This Report is discussed in greater detail in Chapter V below.

legal way, the Report does constitute as authoritative statement as is possible on the position of the Executive Branch on the question of responsibility in the administration of academic research programs. On the question of responsibility, the fundamental proposition of the Bureau's Report is that the legal and administrative authority of institutions must be strengthened through general research agreements entered into between agencies and universities as universities, rather than as collectivities of individual researchers pursuing their own particular interests. As is discussed in Chapter V, the Bureau's position is basically consistent with the President's Memoranda.

The Demand for "Equity" in the Distribution of Federal Academic Research Funds

The most troublesome political issue in the 1960's arising out of the funding of research by federal agencies has been the issue of "equity" in the distribution of funds. The President's Memoranda state that there is a need for a wider distribution of funds, but do not specify the criteria by which this distribution should be effected.

This section examines the nature and sources of the demands for a wide distribution of funds, and the proposals that have been advanced for the achievement of this objective.

The issue of equity in the distribution of federal academic research funds first arose in the course of the debates over the founding of the National Science Foundation in the 1940's. The Association of State Universities and Land Grant Colleges and several other organizations argued that funds should be distributed in part to the states on a population basis.[1]

The rationale underlying the demand for distribution of funds on a population basis was cogently explained by Clarence A. Mills of the University of Cincinnati's Laboratory for Experimental Medicine in an article published in Science in February, 1948.[2] Mills asserted that the distribution of research funds would prove to be of paramount importance to the development of the United States in the latter half of the twentieth century. He

[1]See statement of Edmund Day, President of Cornell University, in U.S. Congress, Senate, Committee on Military Affairs, Science Legislation, Hearings, 79th Cong., 1st Sess., 1945, p. 794. See also, James L. Penick et al. (eds.), The Politics of American Science, 1939 to the Present (Chicago: Rand McNally, 1965), Part 2, Sec. II, pp. 72-90.

[2]Clarence A. Mills, "Distribution of American Research Funds," Science, CVII (1948), 127.

presented the case for distribution on a population basis in the form of an analysis of the distribution of funds by advisory committees of scientists for the American Cancer Society, the International Cancer Research Foundation, the Commonwealth Fund, the Life Insurance Medical Research Fund, the National Foundation for Infantile Paralysis, the National Research Council, the Rockefeller Foundation, the U.S. Public Health Service, and others. Mills found that without exception, funds raised by public subscription throughout the country, and by federal taxes, were disproportionately awarded by members of advisory committees to the institutions from which the committee members came. He stated that he was:

> . . . well aware of the justification usually given for present distributional inequality. The larger research institutions receiving the lion's share of funds are best equipped for the prosecution of research. In practice, however, the basic need is not for quick results but rather for the broadest possible distribution of research opportunity to the country's whole population . . . especially where governmental funds . . . are concerned.

After tracing the pattern of concentration followed by private agencies, he asserted that:

> For Washington, D.C., to follow a similar course with purely public funds . . . would mean a tragedy of major proportions to the scientific development of the country. . . . In the long run, the greatest good to the greatest number would probably be served by receiving the distribution of Federal research funds . . . on a state-population basis.

He asserted that scientists had demonstrated an inability to act without bias in overseeing the distribution of funds in their own fields, and should not be delegated this task by federal agencies. To delegate this responsibility to scientists, Mills argued, would be tantamount to permitting small groups of scientists to capture federal agencies and determine the purposes for which public money should be spent.

> No one believes that the politicians would themselves do any better but theirs is the duty of so legislating that the proper end will be accomplished where public funds are concerned.

The type of argument advanced by Mills was rejected by the "inner group" of scientists allied with traditional, prestigious universities, represented by Dr. Vannevar Bush. Scientists from less prestigious groups generally supported the type of position on distribution expressed by Mills.

In a memorandum sent to John R. Steelman, then serving as a science advisor to President Truman, in December, 1946, by a member of Steelman's staff, the differences between the two groups were summarized as follows:

> The differences between the Bush group and the Urey-Shapely-Condon group are, very broadly speaking, the differences between a small inner group closely allied with a few powerful institutions and large corporations (where most wartime research was conducted), and on the other hand, a larger group of scientists with interests widely spread throughout the nation and with a desire to avoid--insofar as possible--the concentration of research and the power to control it.[1]

The conflict between the two groups on the distribution of funds was resolved by a compromise expressed in section 3(b) of the 1950 Act which created the Foundation. The Foundation is directed to "strengthen basic research and education in the sciences . . . throughout the United States, including its territories and possessions, and to avoid undue concentration of such research and education."

In its First Annual Report, the Foundation expressed its intention to avoid undue concentration of its funds:

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[1] Memorandum from J. Donald Kingsley to John R. Steelman, December 31, 1946, Papers of Harry S. Truman, Harry S. Truman Library, Independence, Missouri, reprinted in Penick, Pursell, Sherwood, and Swain, The Politics of American Science, 1939 to the Present, p. 72.

> The National Science Foundation proposes to support basic research on as broad a geographical and institutional basis as possible.[1]

In the Preface to the same report, however, James Conant, the chairman of the National Science Board asserted that:

> In the advance of science . . . there is no substitute for first-class men. Ten second-rate scientists or engineers cannot do the work of one who is in the first rank.[2]

These two statements reflect the tension between "excellence" and "equity" that has plagued the entire federal academic research funding system in the 1960's.

In its *Third Annual Report*, the Foundation reiterated its intention to avoid undue concentration in the distribution of its funds, but pointed out that the role of the Foundation in providing funds for academic research was a relatively small one compared to the roles of the Department of Defense, the Atomic Energy Commission, and the Public Health Service. In 1952, for example, the Foundation provided less than 2 percent of about $75 million allocated by all agencies to basic research at non-profit institutions.[3]

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[1] National Science Foundation, *First Annual Report, 1951*, p. 16.

[2] *Ibid.*, p. viii.

[3] National Science Foundation, *Federal Funds for Science* (Washington: U.S. Government Printing Office, 1952), Vol. I, p. 16.

The Third Report stated:

> Generally speaking, Federal funds in support of research at universities and colleges have been concentrated in a relatively small number of institutions. However, in evaluating this institutional concentration of funds, one factor must be kept in mind. The Department of Defense, the Atomic Energy Commission, and other agencies which have supplied the greater part of Federal research funds at educational institutions, mainly sponsor research related to the operating functions of the agencies. These agencies need and expect results which further their overall programs, and therefore place research contracts and grants in large, well-equipped, and well-staffed institutions. Regardless of the long-term national goals to be obtained through broader institutional support of research, these agencies on the whole dare not risk any substantial proportion of their research support effort in institutions which cannot quickly and effectively meet their operating needs.[1]

The question of the distribution of academic research funds did not become a major political issue in the 1950's. Writing in 1959, Charles Kidd asserted that "Complaints of favoritism based upon scientific, institutional, or geographic bias have been rare. The most conspicuous example is an article in Science by C. A. Mills, of the University of Cincinnati."[2] The Mills article referred to by Kidd was discussed above.

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[1] Ibid., Third Annual Report, 1953, pp. 34-35.

[2] Kidd, American Universities and Federal Research, p. 199.

One of the reasons the question of distribution of funds did not become a political issue undoubtedly was lack of information on expenditures by agencies at individual institutions. Harold Orlans observed in his study of agency-university relationships in 1962 that information necessary to an adequate analysis of the institutional concentration of funds was either non-existent or unpublished.[1] Orlans accused agencies of deliberately withholding information about their expenditures at individual institutions, and labeled this practice "reprehensible." He was particularly critical of the U.S. Office of Education and the National Science Foundation for their failure to secure and publish this information, because these agencies are by law responsible for keeping track of federal expenditures for research and education. Despite the paucity of information on expenditures at specific institutions, Orlans determined from Office of Education figures that in the period 1947-48 to 1957-58, the proportion of the federal income of all colleges and universities received by the top 20 recipients rose from 32 to 61 percent, or by an absolute amount of $270 million,

[1]Orlans, The Effects of Federal Programs on Higher Education, p. 138.

while income received by the remaining 1,800 to 1,900 institutions declined by $85 million. Federal research and development funds at universities and colleges proper were dispersed somewhat more widely in 1958 than in 1954.[1]

Leading Schools	Percent of Federal R & D 1954	1958
6 schools	33	28
14 schools	56	49
20 schools	66	54
36 schools	81	73

Of the approximately 1,900 institutions of higher education in the United States in this period, about 200 awarded doctorate degrees.

Another reason the distribution of research funds did not become a political issue in the late 1950's may have been the passage of the National Defense Education Act in 1958. This Act, a response to the launching of Sputnik on October 4, 1957, was the largest commitment to national general education up to that time. It was designed primarily to improve the teaching of science, mathematics, and foreign languages at all levels. Some of the provisions

[1] _Ibid_., p. 141.

of the Act relating to higher education were explicitly designed to encourage new graduate centers. Thus, Title IV authorized three-year graduate fellowships for attendance in new or expanded graduate study programs. However, as noted below, Title IV funds also tended to concentrate in prestige institutions.

The first explicit, official recognition by an executive agency that there was a problem in the pattern of distribution of academic research funds that had evolved in the 1950's, was made by the President's Science Advisory Committee in November, 1960, in the report Scientific Progress, the Universities, and the Federal Government. This report was written by PSAC's Panel on Basic Research and Graduate Education, chairmaned by Glenn T. Seaborg, then the Chancellor of the University of California, Berkeley. This report was a direct result of the concern over science education in the United States provoked by the Russian achievements in space.[1]

For a political viewpoint, PSAC might have seemed an unlikely source of support for demands for a wider

[1]The President's Science Advisory Committee had earlier expressed its concern over this problem in a report issued in December 1958, Strengthening American Science, and in a report issued in May 1959, Education for the Age of Science.

distribution of funds. However, PSAC was less concerned about the geographical concentration of funds *per se* than with the very limited number of major institutions in the United States that are strong in science. The members of PSAC in 1960 were almost all from prestigious institutions that have received the lion's share of federal funds.[1] The committee at the time was composed of the following members:

John Bardeen, University of Illinois
George W. Beadle, California Institute of Technology
Detlev W. Bronk, The Rockefeller Institute
Harvey Books, Harvard University
James B. Fisk, The Bell Telephone Laboratories
Donald F. Hornig, Princeton University
James R. Killian, Massachusetts Institute of Technology
Robert F. Loeb, Columbia University
Wolfgang K. H. Panofsky, Stanford University
Emanuel R. Piore, International Bussiness Machine Corporation
Edward M. Purcell, Harvard University
Isidor I. Rabi, Columbia University
Glenn T. Seaborg, University of California, Berkeley
John W. Trenkey, Princeton University

[1]For an analysis of PSAC's membership over time in terms of institutional affiliations, see Carl William Fischer, "Scientists and Statesmen, A Profile of the Organization of the President's Science Advisory Committee," *Knowledge and Power*, ed. Sanford A. Lakoff (New York: The Free Press, 1966), pp. 315-58.

Alvin M. Weinberg, Oak Ridge National Laboratory

Jerome B. Wiesner, Massachusetts Institute of Technology

Walter H. Zinn, Combustion Engineering, Inc.

George B. Kistiakowsky, Harvard, Special Assistant to the President for Science and Technology.

In terms of institutional affiliations, the Panel on Basic Research and Graduate Education was of a similar composition. The basic proposition of the Seaborg Report was that the federal government should not only act as a consumer of university science services, but also become an investor in the scientific capabilities of universities as institutions. The report asserted that basic research and scientific education are two phases of one fundamental process, and that federal policies should be designed to enable universities to carry out both education and research in conjunction with each other. The report praised the project system, but asserted that the project system does not fully meet the needs of federal agencies or of universities. While specific agencies have specific needs that can be satisfied through research projects, the government as a whole should be committed to the development of fields of science for the long term benefits that may result, and to the development of the capacities of universities to conduct both research and science education. In particular, the report denounced the "fundamentally wrong division between research and teaching that bedevils the government's relations with universities." The report indicated that the practice of funding specific research projects is not the best way to promote an integration of basic research and scientific research processes.

Then, in what has proven to be the most seminal part of the report, the Seaborg Panel asserted that there is a need for additional "centers of excellence" in the United States for scientific research and training. The phrase "centers of excellence" appears to have entered into the vocabulary of government-university relationship through this report. The report asserted that while there were fifteen, or at most twenty centers of excellence in 1960, there should be thirty or forty by 1975. "Timely and determined support to the rising centers will be repaid many times over in service to society."

The Seaborg Report was significant for several reasons. One, it stated that the criterion of the educational needs of universities, as well as the criterion of the research needs of agencies, should be used in the formulation and administration of agency research programs. Two, it recognized that federal policies were not geared to the development of "rising institutions," and urged a change in policies to achieve this objective. Finally, the Seaborg Report was significant because it was produced by men who were more or less orthodox members of the rather amorphous "scientific establishment." In and of itself the report did not lead agencies to shift towards broader forms of support or towards wider distribution of their funds, but it did provide support to those in NASA, in NIH, and in NSF who favored changes in these directions. For example, in its announcement of the Science Development Program, NSF cited the Seaborg Report as one of the factors that contributed to the decision to undertake the program.[1]

The Seaborg Report was followed in December 1962, by another PSAC study, Meeting Manpower Needs in Science

[1]See John Walsh, "Centers of Excellence," *Science*, CXLVI, No. 3651 (1964), 1565.

and Technology,[1] the Gilliland Report, named after the chairman of the PSAC Panel on Scientific and Technical Manpower, Edwin R. Gilliland of M.I.T. Like the Seaborg Report, the Gilliland Report called for an extension of the rationale of federal support of research and training, and focused less on the need for the immediate production of research results of use to agencies in the performance of their missions and more on the need for federal investment in science education and training. Like the Seaborg Report, the Gilliland Report stressed the importance of coherent federal support of education and research as an integrated process, rather than federal support of research as a self-contained activity. In this context, the report cited the agricultural research system as the primary example of an integrated system of support of research and education.

> Nowhere are the benefits of scientific research more dramatically revealed than in food production. . . . This accomplishment can be directly attributed to research that has been systematically supported by the Federal Government, the States, and private sources, in programs that have historically and effectively linked education and research. As a consequence, universities have been eminently able to meet changing needs.[2]

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[1]PSAC Study, Meeting Manpower Needs in Science and Technology (Washington: U.S. Government Printing Office, 1962).

[2]Ibid., p. 25.

The report set forth four recommendations for the design and administration of federal research and science education programs. First, agencies should place greater emphasis on the use of training grants administered by institutions. Selection of students should be placed in the institution, and the grants should provide funds to the institution for the costs of instruction, as well as for stipends for students. Grants should be designed to increase the institution's responsibility for recognizing and satisfying its own needs, as well as the needs of the country for additional scientific manpower. Second, there should be a concerted effort to increase the productivity of existing centers of excellence. Third, a concerted effort should be made to encourage the development of new centers of excellence on a state and regional basis. Fourth, federal agencies should recognize that they have become the primary consumers of the output of graduate schools in the areas of engineering, mathematics, and the physical sciences. As a consequence, the responsibility of federal agencies must extend to an assumption of responsibility for the adequacy of scientific manpower in the United States indefinitely into the future. As a practical matter, the report called for the combination of agency programs in research and science education for the achievement of a production of 7,500 Ph.D.'s per year by 1970 in engineering, mathematics, and physical sciences, labelled as the EMP fields. This figure was arrived at through an analysis of the production of Ph.D.'s in EMP fields from 1940 to 1960 in relation to total college population, and through projection of figures on college population in the 1960's and 1970's. The report noted that the Office of Education had projected 5,500 EMP doctorates in 1970, while NSF had projected 6,100. The Gilliland Panel concluded that with adequate federal support, 7,500 EMP doctorates could be attained. In addition to an increase in EMP doctorate production, the Gilliland Panel also called for an increase in the number of EMP students completing a year of graduate training. The Panel's recommendations were adopted as policy guidelines by the Kennedy Administration, and were incorporated into the budgetary requests for fiscal year 1964.[1]

The Gilliland Report was significant in the development of demands for a wider distribution of academic research funds in the 1960's in two ways. First, it reaffirmed support at the Executive Office level of the goal of promoting additional centers of excellence in research and science education on a state and regional basis. Second, it stressed that the criterion of the needs of universities for funds to educate students in the sciences should be included as one element in the criteria used by agencies in designing and administering research and research-related programs.

Despite the attention given to the distribution question in the Seaborg and Gilliland reports, these reports were not directed to an analysis of the distribution question as an important policy problem in and of itself. No attempt was made in these reports to collect and systematize information on the distribution of funds among institutions, nor

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[1] See, e.g., U.S. Congress, Senate, Committee on Aeronautical and Space Sciences, NASA Authorization for Fiscal Year 1964, 88th Cong., 1st Sess., 1963, Part 2, pp. 1121-1122. For an analysis of the impact of the Gilliland Report on scientific manpower policies, see Luther J. Carter, "Manpower: Output of Scientists and Engineers May Exceed Goals Set by White House Committee," Science, CLI, No. 3711 (February 11, 1966), 666.

did the reports recommend dramatic changes in existing policies to effect a major redistribution of funds.

A modest breakthrough in the collection and organization of information on the institutional concentration of research funds was made by the Special Subcommittee on Education of the House Committee on Education and Labor in 1962 in its report, The Federal Government and Education,[1] known as the Green Report, after Representative Edith Green of Oregon, the chairman of the subcommittee.

The Green Subcommittee found that 90 percent of federal academic research funds were concentrated in 100 out of approximately 200 doctorate-awarding institutions. The subcommittee asserted that the remaining 1,900 institutions that received relatively little federal money also played an important role in all phases of higher education in the United States, including the production of scientists, and questioned the wisdom of the existing distribution pattern. The subcommittee also found that 87 percent of the National Defense Education Act fellowships, fellowships specifically intended to spread the development on graduate

[1] U.S. Congress, House, Committee on Education and Labor, The Federal Government and Education, Report of the Special Subcommittee on Education, 88th Cong., 1st Sess., 1963.

programs institutionally and geographically, were concentrated in the same 100 institutions. Specifically, the subcommittee reported that for fiscal year 1962, 38 percent of federal academic research funds was concentrated in the following institutions in the following order:

1. University of California
2. Massachusetts Institute of Technology
3. Columbia University
4. University of Michigan
5. Harvard University
6. University of Illinois
7. Stanford University
8. University of Chicago
9. University of Minnesota
10. Cornell University

Fifty-nine percent was concentrated in 25 institutions and, as noted above, 90 percent in 100 institutions. While the data presented in the Green Report were not as sophisticated as data that have subsequently become available, the report was significant because it constituted an attempt to analyze research programs in the context of the federal government's involvement with higher education.

The issue of distribution of academic research funds became the subject of congressional hearings in 1963 and 1964. The Elliott Committee, which was created by the House in 1963, was the first congressional committee to undertake a general review of the government's total research and development efforts.

In the course of its hearings, the committee provided a highly visible forum for the expression of positions on all facets of government research processes, including the distribution of academic research funds. The existing distribution of research funds was defended by a number of prestigious witnesses, including Logan Wilson, President of the American Council on Education, Alan T. Waterman, President of the American Association for the Advancement of Science, George B. Kistiakowsky, Special Assistant to the President for Science and Technology from 1957 to 1961, and Lee A. Du Bridge, President of the California Institute of Technology. These witnesses defended, on various grounds, the policies and practices that dominated the distribution of research funds throughout the 1950's and early 1960's. Thus, Logan Wilson testified that concentration of research funds was inevitable in view of the relatively short time the government has been heavily engaged in the sponsorship of academic research.

> The Nation had many goals and commitments to be achieved quickly. Agencies responsible for reaching these goals had no choice but to turn to the institutions which had already demonstrated their competence. . . . It seems to me to have been predictable that as the Nation turned to science for the solution of many problems the funds would inevitably be concentrated where the scholars and scientists were.[1]

In spite of the fact of concentration, Wilson argued, in the period 1940-1960 there was a significant broadening of the base of institutional research capability throughout much of the country. Whereas in 1940 there were perhaps 15 or 20 institutions capable of undertaking large scale research projects, in 1962 over 100 universities were conducting research for federal agencies at a rate of $1 million each. Wilson expressed support of programs designed to encourage the further development of research capabilities in potentially

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[1] U.S. Congress, House, Select Committee on Government Research, Federal Research and Development Programs, Hearings, 88th Cong., 1st Sess., 1963, Part 1, p. 509.

great institutions, but vigorously opposed suggestion for the redistribution of existing funds.

Alan T. Waterman, then President of the American Association for the Advancement of Science, supported the existing distribution pattern on grounds similar to those relied upon by Logan Wilson. Waterman asserted that "Bad science is worse than no science, and it is appallingly expensive. . . . The policy adopted by the National Science Foundation is the proper one, namely, to provide for the needs of the highest quality research projects and the most competent investigators wherever they may be found."[1] Like Wilson, Waterman expressed guarded support of programs designed to strengthen developing institutions, but strongly advocated retention of merit and capability as the primary basis of support.

While both Wilson and Waterman acknowledged the importance of research funds to educational processes, neither addressed himself to the argument that the allocation of academic research funds can have significant economic effects, or to the argument that academic research funds should be

[1] Ibid., Part 2, p. 814.

allocated, at least in part, on the basis of the needs of geographical areas for centers capable of performing research on regional problems, particularly problems associated with the development of urban areas.

In contrast to the position taken by Wilson and Waterman, O. C. Aderhold, President of the University of Georgia, presented a classic statement in support of a wider distribution of funds. Implicit in Aderhold's statement was the thesis that academic research funds should be distributed on the basis of four criteria: (1) the criterion of merit, particularly for the immediate realization of specific objectives of operating agencies; (2) the criterion of the educational needs of states and regions within states; (3) the criterion of the economic needs of states and regions; and (4) the criterion of need for research on civilian problems such as transportation and air pollution.

In essence, Aderhold argued that the existing pattern of federal support of research can be explained in terms of a crisis theory of politics. The existing pattern was created primarily through a piecemeal response to specific crises, particularly crises in military affairs and space exploration. Federal support of academic research should not be regarded as a subterfuge for assisting higher education. However, it must be recognized that research funds often benefit the institutions to which they are distributed, particularly in regard to the ability of institutions to attract good faculty and good students.

> Is our national commitment to research one that should be dictated by a succession of crises, or is it one that should be for all seasons? My personal belief is that because research is so closely related to higher education and because of the rapidly advancing technology with all the complexities that it brings, we should look at our resources and programs for research in terms of orderly and comprehensive development in the future.[1]

Ultimately, the obligation for higher education rests with the states. It must be recognized, however, that federal programs now have a major impact on teaching and research activities. Many states have not had the economic and other resources to build institutions capable of meeting the needs of the areas in which the institutions are located. The effect of continued concentration of funds in first-rate institutions would be to further put "have-not"

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[1] *Ibid*., p. 903.

institutions and areas at a competitive disadvantage.

> Institutions with strong research centers have tended to become stronger and wealthier at the expense of weaker and poorer institutions. This has led to a stimulation of economic activity around these stronger, wealthier centers, while other areas have stagnated or have developed more slowly.[1]

New federal research policies should be based on the federal principle of cooperation between the states and the federal government. A certain percentage of research funds, perhaps 25 to 35 percent, should be allocated to the attainment of specific objectives of specific agencies. The bulk of federal academic research funds, however, should be allocated to the states, and to institutions within the states, on a formula basis. The formula should take into account such factors as the college-age population within an area, the economic base of the area, and the efforts being made by individual states. The "crisis-stimulated" program of federal support in the past should be replaced by a national commitment to development of strong research institutions throughout the country on a long-term, stable basis.

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[1] *Ibid.*, p. 908.

Variations on the position taken by Aderhold were expressed by other witnesses such as Novice G. Fawcett, the President of Ohio State University, who testified in behalf of the Association of State Universities and Land-Grant Colleges. He expressed the association's long-standing position that federal academic research funds should, in part, be distributed on a geographical basis, and expressed the judgment that the project grant mechanism is a poor instrument for the realization of this goal. A number of other witnesses, such as Wilford Bailey, the Coordinator of Research of Auburn University, expressed general support of this position.

In his statement to the Elliott Committee, Jerome Wiesner, then Director of the Office of Science and Technology and President Kennedy's Special Assistant for Science and Technology, expressed in a systematic fashion the general position of the Kennedy Administration on the question of geographical distribution. As noted above, the President's Science Advisory Committee in 1960 and again in 1962 issued reports calling for the creation of new "centers of excellence" in research and science education throughout the United States. In a move to implement this recommendation, the Kennedy Administration in its budget for fiscal year 1964 requested $33 million for the creation of a science development program by the National Science Foundation.[1] The House Independent Offices Appropriations Subcommittee disapproved the request, stating that the program was too vague to warrant approval without further explanation of how it was going to be administered.[2] In his appearance before the Elliott Committee in November 1963, Wiesner strongly criticized the action of the House Independent Appropriations Subcommittee for its refusal to approve the administration's efforts to strengthen the role of the National Science Foundation in relation to other agencies in providing funds for academic research generally, and funds for developing universities in particular.

The essence of the position taken by Wiesner was that it is necessary for the government to accommodate both the demands for the preservation of the existing system,

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[1] U.S. Congress, House Committee on Appropriations, Independent Offices Appropriations, 1964, Hearings before the Subcommittee on Independent Offices, 88th Cong., 1st Sess., 1963, Part 2, p. 450.

[2] Ibid., Report, p. 16.

such as the demands expressed in the testimony of Alan T. Waterman and others, and the demands for a "more equitable" distribution of funds, such as the demands expressed by O. C. Aderhold. "We are coming to the situation where we need to examine and rationalize these vast expenditures that go into the universities so that there is a more uniform treatment of schools."[1]

Such a rationalization must be developed out of the context in which federal sponsorship of research and development has evolved. In the 1960's, the United States is undergoing a stabilization of the scientific-military revolution of the 1950's in new weapons technologies. In the 1950's there was often a close relationship between military-oriented research and development and civilian needs, and military efforts made major contributions to the progress of science and technology in the United States. However,

> Weapons research and development can no longer pace our progress to the same extent, and new and possibly more conscious ways of insuring long-range scientific and technological advances are now required. . . . We are confronted with

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[1] _Ibid._, p. 288.

> urgent needs for the application of knowledge to develop substitutes for familiar shortages, to confront pollution in our environment created by industrial and urban life, to meet foreign economic competition, and to adjust imbalances in our economy created by technology itself. We are faced with a necessity of understanding the new implications and possibilities of all these changing needs and opportunities in science, just as we once wrestled primarily with military problems.[1]

In the context of this change in emphasis from military problems to civilian problems, universities will continue to play an important role. In carrying out their applied mission responsibilities, federal agencies should have no choice but to award contracts and grants to universities on the basis of quality and capability to perform research. On the other hand, in the case of basic research there is room for some experimentation in the administration of funds. In the first place, the dual nature of much basic research performed by universities should explicitly be recognized. Although the primary purpose of sponsoring basic research is to promote the development of knowledge and information, advanced training of students in the sciences at the graduate level is inseparable from involvment in research. When properly administered, basic research

[1] *Ibid.*, p. 259.

can serve as an important means to the development of scientific manpower. In the second place, basic research funds in part can be administered to promote the geographical spread of quality scientific faculties and facilities. The problem of maintaining existing centers of excellence and building new areas of high competence should not be approached as an either/or proposition, especially where the continuing effectiveness of existing centers might be at stake. What is needed is an effort to identify potential centers of excellence, with some weight given to geographical factors, and an effort to use federal research funds to help developing institutions help themselves. Furthermore, federal research policies in the future should be designed to recognize that the presence of first-rate educational institutions to carry on federal research has been important to regional economic growth. Several factors help to explain the growth of technological capability in some areas of the country, including: (1) the presence of outstanding scientific schools and faculties, (2) federally sponsored research activities, (3) availability of skilled manpower, (4) diversified supporting industry, (5) readily available venture capital, (6) good transportation, and (7) pleasant living conditions.

While the federal government cannot assume responsibility for the total welfare of the economy of a given area, federal policies can be designed to encourage and help local efforts. One of the problems of technologically underdeveloped regions is to find ways of creating research centers that can stimulate local industrial efforts. "I see an essential role for the Government in stimulating technological innovation in industry as a contributor to economic growth, regional as well as national." Although the final decisions on technological innovation must be made by industry, the federal government can illuminate the basis of choice by designing research and related programs to promote closer relations between industry and university faculites, and by supporting research and development that is basic to the growth of particular industries.

In organizational terms, the role of the National Science Foundation in funding academic research should be strengthened. Mission oriented agencies, with their special interests, cannot be expected to expand in relation to the needs of an increasingly technologically dependent and urbanized society. "NSF must assume a greater role in the support of fundamental research focused on national needs." A wider geographical distribution of centers of excellence is one need that NSF programs should be designed to meet. In addition, the Commerce Department should be given an explicit role in promoting economic growth through programs designed to encourage cooperation among industries, universities, and local communities.

Wiesner's testimony included, at least in a rudimentary form, the elements that could become the basis of a more or less coherent federal academic research policy. These elements are: (1) a recognition that mission oriented agencies must rely predominately on quality criteria in the funding of research deemed to be relevant to the agency's special needs; (2) a recognition that most basic research is valuable not only as a means to the production of information, but also to the development of the educational capacities of universities; (3) a recognition that academic research funds can have important economic effects, both of a national and regional nature, and that these funds should be administered and distributed with consideration given to economic need; and (4) a recognition that the scientific-military challenge of the 1940's and 1950's is being supplemented by a scientific-urban and environmental challenge in the 1960's and 1970's.

The differences between Alan T. Waterman's testimony and Jerome Wiesner's testimony are indicative of the differences between the demands made on the academic research funding system in the 1950's, and the 1960's. The basic premise of Waterman's testimony was that the federal academic research funds should be allocated to universities primarily on the basis of one criterion, the capability of the university to perform the research. The project system is well suited to the realization of this end. The basic premise of Wiesner's testimony was that federal academic research policy should be designed and administered to harmonize with federal educational, economic, and metropolitan policies. The criterion of quality should be supplemented with criteria derived from educational, economic, and metropolitan factors, and the project system should be supplemented with broader forms of support.

Lloyd V. Berkner, the President of the Graduate Research Center of the Southwest, strongly advocated the distribution of research funds in part on the basis of regional educational and economic needs, particularly on the basis of the needs of metropolitan areas.[1] While his testimony was generally in agreement with the position expressed by Wiesner, his testimony was distinctive in the suggestion that metropolitan needs should be used as the criteria for fund distribution. Berkner argued that it is now clear that the United States is involved in a technological revolution, and that this revolution is based in good part on developments in basic science. The widespread growth of science-derived industries is a new phenomenon that has come into visibility since the 1950's. This phenomenon has great implications for the development of industry and for employment in metropolitan areas.

[1] See also, Lloyd V. Berkner, "Graduate Centers: Key to Innovation," Industrial Research, VI, No. 4 (April, 1964), p. 66. Also, D. Allison, "The University and Regional Prosperity," International Science and Technology (April, 1965), p. 22.

These implications can be illustrated by reference to the Dallas-Fort Worth area, an area that has been intensively studied by the Graduate Research Center of the Southwest. In 1950, perhaps 100 Ph.D.-trained scientists and engineers were employed in the area. The economic base of the area was related to oil and agriculture. There was very little science-oriented industry. By the early 1960's, over 1,000 Ph.D.'s were employed in the area, of which only 200 were in universities. About one-third of all industry is now science-oriented. About one-third of the employment of the entire metropolitan area depends on technology that has emerged from science, and much of the new employment since 1950 is in science-oriented industry. One Ph.D. is now required for each 115 workers in the science-oriented industries, and the demand for Ph.D.'s will double by 1970.

The experience of this area indicates that the national production of Ph.D.'s and the federal distribution of research effort are at variance with national and regional need. In 1959, 9,400 doctoral degrees were awarded in the United States, excepting degrees in medicine and law.

Two-thirds of these degrees were granted in ten states, which have 40 percent of the U.S. population. The ten states producing two-thirds of the Ph.D.'s have an average rate of more than 85 doctoral degrees granted per million of population. They are:

Massachusetts	140	Indiana	88
Connecticut	121	Illinois	74
Wisconsin	95	Minnesota	70
Iowa	90	Michigan	62
New York	89	California	59

These figures are significant because students everywhere do not travel to great centers of learning which serve the entire nation, as is often alleged. Fewer than 10 percent of Ph.D. graduates go more than 500 miles from their homes for graduate studies.

In the leading states, from 10 to 15 high school graduates per thousand earn Ph.D.'s, while in the other states, 5 students per thousand earn a Ph.D. The geographical proximity of a major graduate center appears to influence the number of students who earn Ph.D.'s, which indicates that the presence of a graduate school influences community and individual attitudes and motivations. Both in terms of production of Ph.D.'s and employment of Ph.D.'s, ten states with about half the population completely dominate the 40 states with the remaining half.

Furthermore, it is untrue that new and powerful graduate schools are emerging. In 1920, ten graduate schools produced two-thirds of the Ph.D.'s. In 1940, the number had increased to twenty. In 1960, the number was still twenty.

> At the very moment our national situation demands a radical enlargement of graduate education, the emergence of new great graduate universities has come to a dead halt. I submit that this situation calls for a complete, critical, and objective reappraisal of our activities. . . .[1]

The federal government should consciously promote the development of one great graduate institution in the largest 100 metropolitan areas located in the 50 states. Facilities and faculties for basic research must be associated with each of these institutions to provide industry with access to current advances in scientific thinking. Basic research funds are indispensable to the further development of graduate centers for a number of reasons.

[1]House, Committee on Government and Research, Federal Research and Development Programs, Hearings, 88th Cong., 1st Sess., 1963, p. 437.

Graduate teaching without faculty participation in research is sterile. As graduate institutions develop, they must have access to research funds to discharge their teaching obligations. The only way that graduate students can be effectively trained is through actual participation in research under scientific leaders. Furthermore, new insights into scientific problems frequently come from fresh minds in their early contacts with such problems.

What is required is a fundamental change in the entire rationale underlying the support of basic research by the federal government. The federal academic research funding system should be geared to the needs of an urbanized and technologically oriented society.

In its reports, based in part on the hearings and in part on independent inquiries, the Elliott Committee set forth data on the institutional and geographical distribution of academic research funds. The committee reproduced the data set forth in the Green Report indicating that the top universities in the early 1960's received 90 percent of all research and development funds allocated to educational institutions. Three states received 48.8 percent of R and D funds allocated to educational institutions, California with 28.6 percent, Massachusetts with 11.7 percent, and New York with 8.5 percent. When seven more states are added, ten states received 76.3 percent:

State	Percent
Illinois	2.1
New Mexico	5.6
Maryland	5.0
Pennsylvania	3.4
Michigan	2.6
New Jersey	1.9
Ohio	1.9

If research contract centers are excluded in the computations, ten states still received 61 percent of the funds:

State	Percent
New York	14
California	12
Massachusetts	10
Illinois	7
Pennsylvania	5
Michigan	4
Maryland	3
Ohio	3
Texas	3

These percentages were generally constant for the period fiscal years 1961 to 1965.

Despite its analyses of the phenomenon of concentration, the committee did not advocate immediate changes in existing distribution patterns.[1] The committee endorsed the science development program of the National Science Foundation, but expressed opposition to any effort to "radically and forcibly . . . alter the current distribution of basic research project grants to institutions which have achieved, by whatever means, positions of excellence."[2]

Despite the cautious conclusions reached by the committee, the committee's inquiries were significant for several reasons. The committee gathered and organized more information about the federal research and development programs than previously had been available. Furthermore, the committee provided a visible forum for the expression of demands on the research funding system. Finally, the testimony of President Kennedy's science advisor, Jerome Wiesner, constituted a significant

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[1] See in particular, Study Number VI, Impact of Federal Research and Development Programs, Part II, "Impact on Higher Education," pp. 31-52.

[2] Ibid., p. 117.

statement of the efforts of the Kennedy Administration to formulate a coherent policy on the distribution of research funds.

The Elliott Committee hearings which were held in November and December 1963 and January 1964, were followed by the hearings[1] of the Subcommittee on Science, Research, and Development of the House Committee on Science and Astronautics in May and June 1964. These hearings were explicitly directed to an examination of the distribution of federal research funds, as well as to the methods of calculating indirect costs of federal grants. These hearings and the report[2] and study connected with them constitute a thorough exploration of the entire question of the distribution of federal research funds. The report of the committee was issued on February 25, 1965, about

[1] U.S. Congress, House, Committee on Science and Astronautics, Distribution of Federal Research Funds and Indirect Costs re Federal Grants, Hearings, 88th Cong., 2d Sess., 1964.

[2] U.S. Congress, House, Committee on Science and Astronautics, Geographic Distribution of Federal Research and Development Funds, Report of the Subcommittee on Science, Research, and Development, 87th Cong., 1st Sess., 1965, and National Science Foundation, Obligations for Research and Development, and R and D Plant, by Geographic Divisions and States, by Selected Federal Agencies, Fiscal Years 1961-1964, Report to the Subcommittee on Science, Research, and Development of the Committee on Science and Astronautics, 88th Cong., 2d Sess., 1964.

seven months prior to the issuance of the President's Memoranda.

While the hearings are too extensive to be summarized in detail, the testimony of the various witnesses can be summarized in three sections: (1) the testimony of agency representatives who explained the positions of their agencies on the distribution question; (2) the testimony of those who generally supported existing distribution patterns; and (3) the testimony of those who advocated changes in existing patterns.

All of the agency representatives were asked the following question, a question designed to express the pressures for modifying federal research policies to reflect considerations derived from economic and educational policies.

> In view of the close tie between scientific capability and economic development, strong pressures are developing for the distribution of Federal research contracts and grants on the bases of the needs of an area rather than on scientific competence exclusively. Some authorities are strongly against this concept while others believe it is necessary to achieve a balanced scientific and technological base

> throughout the entire Nation. What is your opinion as to the best way to obtain less of an imbalance on a geographical basis while at the same time maintain a high level of technical competence on Federal research projects?

Speaking on behalf of the Department of Defense, Lt. General William I. Ely testified that:

> We tend to follow competence where we find it and therefore consider that greater uniformity in the geographical distribution of our R and D contracts and grants can only be achieved to the extent that more uniform competence is developed.[1]

The Department of Defense is not and cannot be in the business of building competence either in industries or in universities. The missions of the department dictate reliance on one criterion in the allocation of funds, the criterion of quality. On the other hand, in the research programs conducted by NSF, support of research is the primary mission, rather than interest in the results of the research. NSF programs can and should be administered to accommodate regional needs, although competence must always be recognized as the most important ingredient of research.

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[1]House, Committee on Science and Astronautics, Distribution of Federal Research Funds . . . , p. 5.

In response to the assertion by General Ely that DOD seeks competence where it is at the present time, the following exchange occurred:

> MR. RIEHLMAN: The thing that troubles me, General, if we are seeking competence where the concentration of competence is at the present time, how under the sun are you going to permit or allow any other area of the country that does have a degree of competence to break through this circle and get some of these contracts? How is this going to come about?
>
> GENERAL ELY: Well, it comes about through a mixture, I would say, of community endeavor in a certain area plus possibly support from agencies other than the Department of Defense that operate under different criteria, such as the National Science Foundation.
>
> MR. RIEHLMAN: As far as I am concerned, it looks to me as though it is a sealed situation. The people that do have some competence in certain areas of the country are not going to have a chance to participate in these programs unless this situation is broadened. If you look at the economic situation in our country and those areas where we have been having some problems, and you look at the broad picture of concentration in all of our industries, I think this is a pretty serious matter, and I think it needs further evaluation by the Department of Defense.[1]

Ely explained that in two instances DOD did try to disperse its contracts on a geographical basis, particularly contracts with industry. In the 1950's, the

[1] *Ibid.*, p. 15.

Department followed a policy of strategic dispersal. As a result, contracts were awarded to companies for work in areas remote from the traditional areas of industrial concentration. In the late 1950's and early 1960's another dispersal effort was made. This was based on the voluntary action of major research and development contractors to transfer divisions or to establish new ones in "sunshine states," in an effort to attract and retain first-rate personnel. According to Ely, neither of these efforts had a significant impact on the phenomenon of concentration. Ely disagreed with the general proposition that the distribution of funds to universities could be based on criteria different from that regulating the distribution of funds to industry. In all cases, DOD's distribution of funds must be based on criteria of efficiency, economy, and excellence.

As is discussed below, following the issuance of the President's Memoranda, the Defense Department announced that it is inaugurating an academic research program designed to build competency and to contribute to a wider distribution of academic research funds.

NASA was represented before the Daddario Subcommittee by Earl D. Hilburn, an administrator for industry affairs, Ernest W. Brackett, an administrator for procurement policy, and Thomas L. K. Smull, the director of NASA's division of grants and research contracts. They testified that NASA cannot place research projects at universities which do not have the resources to make significant contribution to the agency's missions. On the other hand, as a matter of policy the agency recognizes that in many cases the existence of a strong university or group of universities in a region is of value to the economic and cultural growth of the region. NASA through its sustaining university program, as well as through its project grants, has attempted to encourage broad participation in space-related research. Specifically, NASA has conducted widely publicized conferences designed to encourage participation in space-related research,[1] and has extensively publicized its research needs through periodic announcements distributed throughout the academic community. Ultimately,

[1]See, e.g., National Aeronautics and Space Administration, NASA University Program Review Conference (Washington: U.S. Government Printing Office, 1965).

however, university participation rests in the hands of the university itself.

A broader distribution of research funds might be obtained if federal agencies were provided with more funds to support fundamental research activities at universities, if Congress would permit greater flexibility in the administration of funds and encourage agency efforts geared to administrative innovation and experimentation, and if local governments and economic interests would undertake the creation of the minimum competence necessary to justify awards by mission-oriented federal agencies to local institutions.

Once a minimum competency has been established by a university, the sustaining university program is specifically designed to enable institutions to build on that competency through predoctoral training, research facilities construction, and special purpose research grants, often of an interdisciplinary nature. Through extensive negotiations between NASA and the university, an effort is made to assure that the institution pays adequate attention to

NASA's research requirement, while at the same time the institution attempts to develop its own capabilities in light of its own needs.

The rationale underlying the distribution of academic research funds by the Atomic Energy Commission was explained by Gerald F. Tape, Commissioner of the Commission. Like the representatives of DOD and NASA, he emphasized that the mission requirements of the Commission largely dictate its placement of academic research funds. As a matter of policy, geographical distribution is not an explicit criterion in the selection of university researchers. However, in the late 1940's, AEC inherited a number of large facilities in various regions of the country, and in many instances cooperative research relationships have been established between these facilities and the universities of the region. This is well illustrated in the case of Oak Ridge National Laboratory in Tennessee. Cooperation between the universities and the region is promoted by the Oak Ridge Institute of Nuclear Studies, a not-for-profit organization of southern educational institutions. The effect of cooperation between the Oak Ridge Laboratory and the Institute of Nuclear Studies is revealed in the figures on AEC support of research in southern universities, support in good part based on proposals made by researchers after experience with AEC's operations at the Oak Ridge Laboratory. Thus, in fiscal year 1950, AEC's obligations for support of research in the basic physical sciences outside of AEC's own laboratories were \$6.8 million. Only 2 percent of these obligations were for contracts in the South. In fiscal year 1955, the percentage had risen to 7 percent, in 1960 to 11 percent, and in 1963, to 12 percent.

In light of this experience, AEC when undertaking new, large projects is committed to trying to meet the objective of fostering nuclear research on a nationwide basis, rather than on a narrow, geographical basis. In the case of major facilities, such as the large linear accelerator under construction at Palo Alto, California, in 1964, under a contract with Stanford University, AEC's policy is to promote regional and national managements insuring access to the facilities by researchers from many universities. While it is true AEC's facilities and research contracts are located more heavily in the Northeast and the Far West than in other regions of the country, AEC cannot use geographical need per se as an explicit criterion in the future location of its funds, although AEC can and does enter into cooperative arrangements with universities desiring to expand their competence in nuclear areas. Explicit development programs calling for broad forms of support, however, are beyond AEC's province, and should be created by Congress and entrusted to the National Science Foundation.

The testimony before the committee of representatives of other agencies differed in some ways, as a matter of emphasis, from the testimony of the representatives of DOD, NASA, and AEC. William H. Stewart, testifying for the Department of Health, Education, and Welfare, stated that the criterion of geographical distribution has not in the past been given explicit weight in the allocation of NIH research funds, although he emphasized that the one hundred educational institutions that received the preponderant share of NIH funds are spread widely among 40 states.[1] Explicit weight will be given by HEW to geographical location in the administration of the Higher Education Facilities Act of 1963, which authorizes a five-year program of matching grants for the construction of academic facilities, and in the administration of the Health Professions Act of 1963, which authorizes construction grants for medical, dental, and other health professional schools. However, he concluded that:

> What has been accomplished to date including both the character and distribution of activity comprehended in current programs has derived from programs brought into being for the achievement of national objectives whose accomplishment required scientific activity in institutions of higher education. In such programs science, intellectual activity, institutional programs, are means--not ends. Thus, these programs are substantially limited in their capability to serve as means of expanding and strengthening our universities and other nonprofit organizations throughout the country. To accomplish the objectives of a better geographical balance of our intellectual resources and research programs we need new and different criteria and a framework for their application aimed directly and explicitly toward the creation of new centers

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[1] For a thorough analysis of the distribution of NIH funds, see U.S. Department of Health, Education, and Welfare, Public Health Service, NIH Obligations to Institutions of Higher Education, Fiscal Year 1965, Parts 1 and 2 (Washington: Department of Health, Education, and Welfare, 1965).

> of excellence in higher education, research, and scientific activity and the strengthening of existing institutions.[1]

As noted in the discussion of NIH programs above, NIH in 1965 created a Health Sciences Advancement Support Program designed, in part, to contribute to a wider distribution of funds on a geographical basis.

The testimony of J. Herbert Hollomon, the Assistant Secretary of Commerce for Science and Technology, differed materially from the testimony of representatives of the other agencies. He emphasized that the concern of the Department of Commerce is generally different from that of other agencies, in that if science and technology were supported for the purpose of advancing the national economy, the criteria used in fund distribution would differ radically from the criteria used in the existing system. Hollomon asserted that geographical imbalances in the allocation of funds to industries and universities have resulted in good part because the federal government has committed itself to the support of large national programs with specific goals rather than to the promotion of the

[1]House, Committee on Science and Astronautics, Distribution of Federal Research Funds . . . , p. 118.

development of the total technical resources of the country. Given the nature of the missions of the major agencies, imbalances were bound to occur. The important task is to determine why some areas of the country are better off in terms of technological development than others.

> We should examine the reasons why some parts of the country are not considered areas of sufficient excellence to attract federal R and D. This should be done, not with the idea that federal contracts and grants are the economic answer for these regions, but with the thought that if these regions are not good enough to receive federal R and D contracts and grants, then they will probably not attract new industry based on technology. They will be unable to push for their own economic development in this age of technology.[1]

Two developments make it essential for the federal government to provide closer ties between the industry and the universities of a region through the provision, on a geographical basis, of funds designed to crystallize local research initiative. The first of these developments is increasing international economic competition. The second of these developments is the shift of economic activity in the United States from agriculture to manufacturing

[1] *Ibid.*, p. 211.

to service, and the shift in our major economic needs from individual products to group needs such as large transportation systems, water resources, environmental health, and other needs created by urbanization. There has been a failure to match federal support of scientific and technological research to the needs generated by the urbanization of the country. The basic imbalance in federal support of research, including academic research, is less a geographical imbalance than an imbalance in the types of research supported. The basic imbalance is that we support little science and technology in the United States for the purpose of improving the national economy and social welfare.

Two things need to be done. The first is to support research in those fields of science and technology that are important to local problems throughout the country, such as transportation, construction, and pollution. The second is to work out, on the model of agricultural research and extension activity, a method of disseminating information relevant to regional economic and technical needs. Finally, the major national programs such as space exploration, defense, and atomic energy, require the allocation of funds on the basis of competence. Any other approach would be wasteful, and could jeopardize the programs. The problem of broadening the base of scientific and technological resources is a separate matter, and should be approached through programs specifically geared to this purpose. As the research funds of mission-oriented agencies level off or decline, funds should be re-directed into programs designed to strengthen scientific and technological capabilities on a geographical basis.[1] In legal and administrative terms, these new programs should not be based on the principles of the project system, but on principles of federalism that call for active participation by the states as well as by local governments, universities, and industries.

As noted in Chapter III, Congress in 1965 enacted Public Law 89-182, the State Technical Services Act, which is designed in part to achieve some of the objectives

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[1] For an analysis of some of the opportunities and problems in shifting from defense and space-oriented to urban-oriented technological activity, see U.S. Arms Control and Disarmament Agency, Defense Industry Diversification, An Analysis with 12 Case Studies (Washington: U.S. Government Printing Office, 1966), and materials cited therein.

propounded by Hollomon.

Most of the agency representatives before the Daddario Subcommittee stressed the fact that the National Science Foundation is the only agency specifically charged by law with responsibility for promoting the development of the scientific strength of American universities and colleges. In his testimony before the subcommittee, Leland J. Haworth, the Director of the Foundation, agreed with this observation, but pointed out that:

> NSF has had available to it such a small fraction of the total Federal R and D funds that no one can reasonably expect us to accomplish a great deal more by way of geographical distribution--unless additional resources specifically dedicated to this purpose can be provided.[1]

It is quite clear, Haworth asserted, that if a wider geographical distribution of funds is to be attained, agencies other that NSF must participate in the effort.

> Just as the Science Foundation is urged by Congress to take geography into account, to take distribution into account, other things being equal, then I feel the other agencies should too, although in general their acts don't have a similar statement.[2]

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[1] House, Committee on Science and Astronautics, _Distribution of Federal Research Funds_ . . . , p. 74.

[2] _Ibid_., p. 80.

Haworth asserted that in general it is not possible to achieve greater uniformity in the geographical distribution of funds without affecting the quality and cost of research. Capability simply is concentrated geographically, and the maintenance of high quality support will continue to result in concentration until a broader geographic base of capability is built, an enterprise that will take time and money. On the other hand, it is possible to identify universities and departments in universities that are capable of improvement. A substantial increase in funds will be necessary, however, to bring this improvement about. While detailed analysis of NSF grants, particularly those for educational purposes, indicates a good measure of success in spreading funds both geographically and institutionally, it is unreasonable to expect NSF to bring about any drastic changes in the over-all distribution pattern unless additional resources specifically dedicated to this purpose are forthcoming.

Specifically, the federal government has three objectives in its support of research and development.

The first objective is to ensure that there is a solid base for scientific and technological developments on a national level. This consists of two elements, good research supported on quality criteria, and science education, also supported on quality criteria. This first objective is the primary mission of the National Science Foundation. The second objective is to carry out research and development for things that the federal government itself needs in the areas of defense, space, and other activities. This objective is the primary responsibility of mission-oriented agencies. The third objective is to promote research and development in areas of activity where the public, rather than the government, is the customer, such as health, power, water, transportation, and, in broader ways, education and economic development. In terms of supporting research and development, the third objective has not been vigorously supported by any particular agency or group of agencies, with some exceptions such as agriculture and health.

NSF's regular programs designed to achieve the first objective must continue to be based on quality as the primary criterion of support. Secondarily, however, NSF recognizes the need to build centers of excellence in regions of the country where none presently exist. The building-up process should not be confused with the process of continuing to support quality research where competent researchers are located. In long range terms, it should prove possible to create additional centers of excellence, but this process will take a long time. Finally, it should be emphasized that the exact relationship between regional economic development and regional scientific capability is not clearly understood. In any event, NSF has no authority to initiate actions which have economic and social development as a primary objective. While NSF can apply geographic criteria to its programs, particularly its educational programs, the criteria pertain to the needs of an area for basic research and education in science, not to needs for economic development.

> The Foundation believes that the most effective way for it to work toward a better geographical balance is to provide special programs which

> are designed to assist academic institutions to strengthen themselves. In such programs criteria of quality would be applied but in terms of future development rather than present cability.[1]

In legal and administrative terms, such programs will involve committment of funds to institutions and to subdivisions of institutions, rather than to individual investigators.

Several witnesses before the committee challenged in various respects the equity and wisdom of existing policies regulating the distribution of funds, including George D. Humphrey, the President of the University of Wyoming; Kenneth S. Pitzer, the President of Rice University; Elvis J. Stahr, the President of Indiana University; Elmer Ellis, the President of the University of Missouri and of the Association of State Universities and Land Grant Colleges; Lloyd V. Berkner, the President of the Graduate Research Center of the Southwest; Clarence H. Danhof, a member of the governmental studies department of the Brookings Institution, and Frederick Seitz, President of the National Academy of Sciences. The existing system was generally supported, with variations, by Herbert E. Longenecker, President of Tulane University; Lee A. Du Bridge, President of the California Institute of Technology;

[1] *Ibid.*, p. 91.

Kingman Brewster, President of Yale University, and Logan Wilson, President of the American Council of Education.

While the positions taken by each of these witnesses had its unique aspects, the basic differences between the two groups can be illustrated by reference to the positions of Frederick Seitz, President of the National Academy of Sciences, and Kingman Brewster, President of Yale University.

Frederick Seitz pointed out that prior to World War II most basic science in the United States was concentrated in a few academic, industrial, and governmental institutions, primarily institutions on the east and west coasts, and in the Midwest. There were about a dozen universities extensively engaged in research, and these universities were primarily funded through local initiative. The major exception to the principle of local financial support was the federal agricultural research system. In World War II and thereafter, individual scientists became the primary recipients of federal research funds. Since the postwar period was dominated by a desire to build up national strength in science, it was reasonable that federal support was based largely on the prewar pattern of strength and the trends of geographical distribution which arose out of the war. Since World War II the established centers of strength have greatly benefited from federal support, although all geographical regions in varying degrees have been helped. In the 1960's it has become apparent that trends reinforcing geographical inequality could become exceedingly important in the future, particularly if the rate of growth of research funds is curtailed. It is possible that federal money would be centered more and more in a small number of institutions in a small number of states, to the harm of other institutions and states.

> I am inclined to believe that it would be a great national tragedy if all the strength provided from the governmental support of science were ultimately to reside in just a few institutions located in a relatively small portion of the geographical area of our great country.[1]

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[1] *Ibid.*, p. 355.

It is reasonable to propose in the 1960's, now that major advances in research have been made through past policies, that explicit action be taken at the federal level to guarantee that the federal support of basic research which is now essential for intellectual, educational, and technological development, reflect in part the future needs of the country.

The pattern of federal support of agriculture provides the basic model on which future programs should be based. Support in many fields of science should be provided on a regional basis under conditions which would allow flexibility in decision making both by those responsible for the programs in Washington, and by those responsible for the programs in universities. In addition, a coordinated effort on the part of the government as a whole should be made to distribute federal research facilities and establishments throughout the country, and to promote strong interactions among federal establishments and local universities.

In contrast to the testimony of Frederick Seitz, Kingman Brewster, the President of Yale, vigorously defended the existing distribution pattern. He asserted that:

> Whether we are talking about research or education, it seems to me wholly unwise to permit considerations of political geography to control the choices of faculties and students alike. . . . Because the excellent are so few, and because modern science cannot very often be pursued in isolation from a community of one's peers, a productive science policy is bound to lead to a high degree of concentration in relatively few centers of advanced education and research.[1]

University education and research are worth supporting because these processes create more scientists and create new knowledge.

> This is the national asset value of American universities, and it is terribly important that it shall not be distorted, corrupted, or destroyed by methods of support which have their origin in the political economy of geographical interest groups. . . .[2]

Brewster vigorously supported the project system, arguing that the system of individual projects and peer evaluation is the only system that can ensure quality in the support of research. He agreed in theory that centers of excellence in various regions or states that do not have such centers would be desirable, but asserted that

[1] _Ibid_., p. 448.

[2] _Ibid_., p. 449.

government policy should not be designed to promote such centers. "Growth of centers of excellence should be the byproduct of an effort to achieve a scientific objective. Let the geographical distribution be the byproduct, rather than the objective." The best way to promote a wider distribution of research funds is to support the training of more scientists in existing centers of excellence, and then encourage these scientists to go to weaker institutions. In addition, greater effort should be made to improve science education at the high school and undergraduate level.

In its report[1] based on the hearings and information submitted to the National Science Foundation by the agencies at the committee's request, the committee set forth information to the effect that in terms of absolute amounts of research and development funds received, ten states received 80 percent of all funds distributed to universities and colleges by all agencies in 1963. When the states were ranked by the amounts of funds received by educational institutions in the states, in fiscal

[1] House, Committee on Science and Astronautics, Geographic Distribution of Federal Research and Development Funds, Report, 89th Cong., 1st Sess., 1965.

year 1963, the result were as follows:

	State	Amount	Percentage of Total
1.	California	$426,778	28.7
2.	Massachusetts	175,226	11.8
3.	New York	126,778	8.5
4.	Illinois	105,537	7.1
5.	Maryland and District of Columbia	89,065	6.0
6.	New Mexico	83,451	5.6
7.	Pennsylvania	50,581	3.4
8.	Michigan	39,233	2.6
9.	New Jersey	28,770	1.9
10.	Ohio	28,577	1.9
11.	Texas	27,062	1.8
12.	All other states	307,858	20.7
	Total	$1,488,916	100.0

The figures used by the committee included obligations for both research and development, and obligations at both universities proper and at contract centers. The committee pointed out that while there are obvious inequalities in the distribution of funds, inequality in this context is not synonymous with inequity. There is no common agreement on the criterion or criteria that might be used to measure equity and inequity in the distribution of funds. Student enrollment in educational institutions in each state is one possible criterion. Measured by this criterion, the ten states receiving the largest amount per pupil are:

	State	Amount
1.	New Mexico	$4,002
2.	Alaska	2,863
3.	Nevada	2,201
4.	Massachusetts	1,132
5.	Maryland and District of Columbia	782
6.	California	749
7.	Illinois	450
8.	Idaho	405
9.	Rhode Island	399
10.	New York	311

By this standard, the leading states, measured by absolute amounts received--California, Massachusetts, and New York--are displaced by New Mexico, Alaska, and Nevada, although California, Massachusetts, and New York still place in the first ten.

Another possible criterion of equity is the amount received by educational institutions within a state per advanced degree in science conferred by the institutions within the state. By this measure, Nevada, Alaska, and New Mexico again lead the other states. Table 37 sets forth the rank order of the 50 states by this standard.

The committee acknowledged that other criteria for the measurement of equity and inequity in the distribution of funds have been proposed, such as the amounts allocated to educational institutions per scientist employed by the institutions, the amount of funds received by a state in relation to federal taxes contributed, and the size of the population of each state. However, the committee pointed out that important factors requiring the exercise of judgment cannot always be expressed in numerical terms, and in its conclusions did not recommend the adoption of any quantitative measure of equity. However, the committee did emphasize the importance for some purposes of analyzing research and development funds to educational institutions in the context of an analysis of all kinds of research and development funds allocated to all performers within a state or region.

TABLE 37

DOLLARS FOR R AND D TO EDUCATIONAL INSTITUTIONS IN FISCAL YEAR 1963 PER ADVANCED DEGREE CONFERRED DURING THE 1962-1963 SCHOLASTIC YEAR, BY STATE
(thousands of dollars)

State	Amount	State	Amount
1. Nevada	$195.6	26. Colorado	7.2
2. Alaska	136.1	27. Ohio	7.0
3. New Mexico	123.3	28. Oregon	6.9
4. California	46.7	29. Texas	6.7
5. Idaho	27.6	30. Alabama	6.7
6. Massachusetts	27.0	31. North Carolina	6.6
7. Maryland and District of Columbia	25.8	32. South Carolina	6.4
		33. Missouri	6.3
8. Illinois	16.9	34. Michigan	6.3
9. Rhode Island	16.8	35. Delaware	6.2
10. New Hampshire	13.9	36. Tennessee	5.8
11. New Jersey	13.0	37. Kentucky	4.9
12. Washington	12.1	38. Mississippi	4.7
13. Utah	11.4	39. Arizona	4.6
14. Minnesota	11.1	40. Montana	4.6
15. Virginia	10.9	41. Nebraska	4.4
16. Iowa	10.9	42. Maine	4.2
17. Florida	10.3	43. Arkansas	4.2
18. Pennsylvania	9.6	44. Oklahoma	3.9
19. Hawaii	9.2	45. Kansas	3.8
20. New York	8.9	46. West Virginia	3.5
21. Georgia	8.7	47. Indiana	3.4
22. Vermont	8.1	48. North Dakota	2.6
23. Connecticut	8.1	49. South Dakota	2.5
24. Wisconsin	8.0	50. Wyoming	2.1
25. Louisiana	7.6		

Source: U.S. Congress, Committee on Science and Astronautics, Geographic Distribution of Federal Research and Development Funds, Report of the Subcommittee on Science, Research, and Development, 89th Cong., 1st Sess., 1965, p. 16.

From its study, the committee concluded that there is a need for new centers of excellence in various regions of the country, particularly because of the potential economic importance of such centers.

> The subcommittee agrees with some of the authorities that the development of a research and technology center of first grade excellence does not necessarily insure the creation of a dynamic and noble economy in the surrounding area. But it also believes that, without such a center, the long-range economic health of a community will in most cases suffer. Furthermore, the subcommittee is forced to conclude that without some Federal stimulus, notwithstanding the requirement for local initiative and community and State support, slow progress will be made in the development of new centers of excellence in research with the result that existing centers will tend to become larger at the expense of other regions of the country.[1]

The committee recommended: (1) that existing federal programs devoted to expanding the national base for science and technology be directed to help institutions that have taken the initiative in improving their capabilities; (2) that NSF be provided with additional funds for the specific purpose of contributing to the development of one major center of excellence in every

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[1]House, Committee on Science and Astronautics, Geographic Distribution of Federal Research and Development Funds, Report, 89th Cong., 1st Sess., 1965, p. 52.

region of the country; and (3) that mission-oriented agencies expand their efforts to contribute to new centers, because of the potential importance of new centers to the achievement of an agency's specific goals in the future.

The Daddario Committee did not call for a major redistribution in the existing patterns, nor did the committee call for a fundamental change in the rationale underlying the existing distribution of funds. As the Elliott Committee had done earlier, it served primarily as a forum for the expression of demands on the system, and a source of further information about the system.

The third major congressional examination of the distribution of research funds was undertaken by the Senate Committee on Labor and Public Welfare, Subcommittee on Employment and Manpower, in June and July 1965.[1] Although the Subcommittee on Employment and Manpower is headed by Senator Clark of Pennsylvania, these hearings were chairmaned by Senator Gaylord Nelson of Wisconsin, because of

[1] U.S. Congress, Senate, Committee on Labor and Public Welfare, _Impact of Federal Research and Development Policies on Scientific and Technical Manpower_, Hearings before the Subcommittee on Employment and Manpower, 89th Cong., 1st Sess., 1965 (hereafter referred to as Senate, Committee on Labor and Public Welfare, _Impact of Federal Research and Development Policies_ . . .

Senator Nelson's interest in the distribution and utilization of scientific manpower. His interest in turn is a reflection of the concern in many midwestern states over the relatively small amounts of federal research and development funds received by midwestern states. In fiscal 1963, for example, not one of the midwestern states was a leading recipient of federal research and development funds. In fiscal 1963, California received 38.9 percent; New York, 9.4 percent; Massachusetts, 4.6 percent; Maryland and the District of Columbia, 4.5 percent; Pennsylvania, 3.6 percent; Texas, 3.4 percent; Washington, 3.3 percent; New Jersey, 2.9 percent; Florida, 2.5 percent, and Missouri, 2.4 percent. Together, these states received 75.5 percent of the funds. In contrast, Illinois received 1.9 percent; Ohio, 1.9 percent; Michigan, 1.4 percent; Wisconsin, 1.0 percent, and Indiana 0.5 percent.

The failure of the Midwest to secure more research and development funds probably is attributable in part to the concentration in the Midwest of industries primarily concerned with the production of traditional consumer and producer goods such as aircraft and vehicles, rather than with electronics and missiles, the significant areas of change in defense technology in the 1950's.[1] At any rate, concern over the difficulties experienced by midwestern states in obtaining federal research and development funds crystallized in the early 1960's in the efforts of a group of midwestern universities to induce the Atomic Energy Commission to construct a $170 million high energy accelerator at the University of Wisconsin campus in Madison.[2]

In December 1963, President Johnson revealed that the request for the accelerator had been denied. The denial was met by vigorous protests. Although the protests failed to bring about a change in the decision, the selection in December 1966 of Weston, Illinois, as the site for a costlier accelerator may have been influenced by the earlier protests. According to Daniel S. Greenberg,

> The well-organized and vociferous gripes of the Midwest over distribution of federal R & D funds . . . drove the AEC to conduct an unprecedented nationwide competition for the accelerator. Just how the noise emanating from the Midwest influenced

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[1]See Roger E. Bolton, Defense Purchases and Regional Growth (Washington: The Brookings Institution, 1966), pp. 123-26. See also the statement of Ron M. Linton, in U.S. Congress, Senate, Select Committee on Small Business, Impact of Defense Spending on Labor Surplus Areas, 1962, Hearings, 87th Cong., 2d Sess., 1962, p. 59.

[2]See Daniel S. Greenberg, "When Pure Science Meets Pure Politics," The Reporter, XXX (March 12, 1964), p. 39.

> the decision of the five commissioners is not clear, but it is a common view among the elder statesmen of high-energy physics that if the Midwest had not set off a political storm in 1963 after Johnson refused to provide funds for a new accelerator in Wisconsin, the 200-Bev machine would be built in the neighborhood of the Berkeley group that fathered it.[1]

The Nelson hearings were not limited to an examination of policies regulating the distribution of academic research funds. The hearings were directed to an examination of policies regulating academic research distribution primarily as such policies are related to the placement of federal defense and space contracts in particular, and regional economic development in general.[2] The hearings exemplify demands for formulating academic research funding policy in the context of a more general federal regional development policy. Senator Nelson explained the purpose of the hearings as follows:

> We hope to learn why the present distribution of Federal research and development funds is what it is, to what extent this is inevitable or useful, to what extent it promotes the

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[1]Daniel S. Greenberg, "200-Bev: Illinois Chosen in Competition for New Accelerator," Science, CLIV, No. 3756 (December 23, 1966), 1528.

[2]Somewhat similar hearings were held by the Senate Select Committee on Small Business in 1963-64. See U.S. Congress, Senate, Select Committee on Small Business, The Role and Effect of Technology in the Nation's Economy, Hearings before a Special Subcommittee, 88th Cong., 1st Sess., 1963.

> development of various regions, or hinders the development of others, to what extent the pattern derives from established policies, to what extent it is the result of initiative or lack of initiative in given regions, to what extent existing policies are serving the national goal of wise utilization of our manpower and wise employment of all of our resources, and to what extent new policies might be in order.[1]

Senator Nelson acknowledged the committee would be accused of engaging in pork-barrel politics, but disavowed any intention to do so. He asserted that the only effective way of avoiding pork-barrel politics is to examine the nature of the relationships between regional economic development and research, and then to design and implement policies to help technologically underdeveloped areas of the country. He asserted that, "the heartland of America is experiencing a 'brain drain' to the coasts," and stated that the universities and industries of the Midwest must be helped through federal action designed to cope with the problem. Some of the witnesses before the committee emphasized the particular problems of the Midwest, but most of the witnesses addressed themselves to the more general

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[1] Committee on Labor and Public Welfare, Impact of Federal Research and Development Policies . . . , p. 4.

question of the relationships between research and economic development. As in the Elliott and Daddario hearings, several witnesses argued that the present policies and procedures regulating federal support of academic research need major revisions, while others argued that the existing policies and procedures are basically sound.

Fred Harvey Harrington, the President of the University of Wisconsin, was one of those who advocated change. His statement was one of the bitterest statements on the distribution of research funds that has been made before any of the committees. He asserted that failure to provide for geographical spread of federal defense and space contracts, and federal academic research funds, has put the country on the road to economic and social chaos. It is imperative that existing distribution patterns be changed towards the development of a pattern based on the long-range economic and social advancement of all regions. Gross inequities in existing patterns are obvious. With about four times the population of Wisconsin, California has more than seven times as many scientists and engineers.

As of 1963, California had produced in this century 6,136 Ph.D.'s in the sciences and engineering, but in 1963, 8,005 scientists were employed in the state. In the same period, Wisconsin had produced 3,286 Ph.D.'s, but in 1963 employed only 1,226. These figures do not show that contracts go where the brains are. They show that the brains go where the contracts are. In 1961-65, California received 38.5 percent of federal research and development contracts. Wisconsin received less than 1 percent. California educational institutions received 28 percent of all federal research and development funds going to educational institutions and related contract centers, while Wisconsin received 1 percent, although Wisconsin has a high output of Ph.D.'s in science and engineering.

Regions that are not major beneficiaries of federal contracts resent what they think is political favoritism. "They blame all levels of Government and lost some of their faith in the justice and honesty of Government--faith that is necessary for effective democracy. They tend to resent the favored region too, and look for some way to even the score."[1] On the other hand, heavy concentration of funds in favored regions may not be good for those regions. Cutbacks in federal spending could lead to serious unemployment, and undesirable political pressure on Washington. There is a desperate need for the development of a coherent federal policy designed to contribute uniformly to regional and national economic growth on a stable basis.

Similar testimony was given by Representative Robert Duncan of Oregon. He argued that the policy of permitting agencies to assign projects and grants to universities on the basis of short-run agency missions is widening the gap between first-, second-, and third-rate universities. The long-range welfare of the nation is being sacrificed to the short-range advantages of federal agencies. The finest minds from areas of technological poverty created by the piecemeal, _ad hoc_, individual policies of federal agencies, are going to the established centers which have maintained preeminence as a direct result of federal support. Representative Duncan challenged the argument that funds

[1] _Ibid_., p. 72.

must be assigned where competent performance is assured:

> The Department of Defense has argued that it "must secure contracts with organizations which can carry out a research and development program in the most efficient manner. . . ." I challenge this assertion on the grounds that the mission approach of the Department of Defense cannot be considered apart from the broad national interest, nor apart from the necessity in the long run for a broad base for our defense efforts.[1]

He called the National Science Foundation's science development program a fine gesture, but asserted that in terms of re-distributing funds the program will be as effective as "using a tack hammer to drive a railroad spike." He concluded with an assertion that the disparity of opportunity created by the concentration of ability in a few sections of the nation, particularly southern California, New York City and northern New Jersey, and the Boston-Cambridge area, must be ended by strong federal action. He did not, however, state what the nature of this action should be.

As in previous hearings, representatives of the major research-funding agencies defended current distribution policies, while generally stressing those programs specifically designed to contribute to a wider distribution

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[1] Ibid., p. 97.

of funds. The most direct and detailed defense of existing policies was made by Donald Hornig in his capacity as the director of the Office of Science and Technology.[1] Hornig asserted that federal research and development funds have without doubt contributed to the quality of advanced training provided by universities with strong research traditions. However, since most academic research funds have been allocated in response to proposals that are judged on the basis of merit, the funds have been concentrated in about fifty institutions. These institutions in turn have produced teachers who have gone to other universities and colleges throughout the country, and have helped to establish research activities in institutions without strong research traditions. These developing institutions have in turn produced good proposals and received funds under the project system.

Hornig argued that, measured by the distribution of Ph.D. production in the United States, the general effect of federal funds has been beneficial. Referring to data compiled by the National Academy of Sciences, which is

[1] Ibid., pp. 40-79.

reproduced in Table 38, Hornig pointed out that a comparison of doctoral production by region in the period 1940-49, with the period 1960-61, indicates important shifts away from the more productive areas in favor of the less productive ones.

In 1940-49, the south central states, Kentucky, Tennessee, Alabama, Mississippi, Arkansas, Oklahoma, Texas, Louisiana, with 17.9 percent of the population of the United States, produced 2.5 percent of the Ph.D.'s, a ratio of Ph.D.'s to population of .14. In 1960-61, this region, with 16.2 percent of the population, produced 6.5 percent of the Ph.D.'s, a ratio of .40. The second most "under-developed" region in terms of doctorate production, the mountain region consisting of Montana, Wyoming, Nevada, Colorado, New Mexico, Arizona, Utah, and Idaho, with 3 percent of the population in 1940-49, produced .8 percent of the Ph.D.'s, a ratio of .27. In 1960-61, with 3.8 percent of the population, this region produced 2.7 percent of the Ph.D.'s, a ratio of .71. In the third underdeveloped region, the South Atlantic region composed of Delaware, Maryland, West Virginia, Virginia, North Carolina, District of Columbia,

TABLE 38

COMPARISON OF Ph.D. PRODUCTION AND POPULATION IN THE UNITED STATES, 1940-1949 AND 1960-1961, BY REGION

Region	1940-49			1960-61		
	Ph.D. (%)	Population (%)	Ratio	Ph.D. (%)	Population (%)	Ratio
New England: Maine, New Hampshire, Vermont, Massachusetts, Rhode Island, Connecticut	12.6	6.4	1.97	9.8	5.9	1.66
Middle Atlantic: New York, New Jersey, Pennsylvania	22.5	20.8	1.08	20.1	19.1	1.05
East North Central: Ohio, Indiana, Illinois, Michigan, Wisconsin	31.8	20.6	1.55	28.1	20.2	1.39
West North Central: Minnesota, Iowa, Missouri, North Dakota, South Dakota, Kansas, Nebraska	11.8	10.8	1.09	9.8	8.6	1.14
South Atlantic: Delaware, Maryland, West Virginia, Virginia, North Carolina, District of Columbia, South Carolina, Georgia, Florida	7.3	12.9	.57	8.8	14.5	.61
South Central: Kentucky, Tennessee, Alabama, Mississippi, Arkansas, Oklahoma, Texas, Louisiana	2.5	17.9	.14	6.5	16.2	.40
Mountain: Montana, Wyoming, Nevada, Colorado, New Mexico, Arizona, Utah, Idaho	.8	3.0	.27	2.7	3.8	.71
Pacific: Washington, Oregon, California, Alaska, Hawaii	10.6	7.0	1.52	14.3	11.8	1.21

Reproduced from U.S. Congress, Senate, Committee on Labor and Public Welfare, Impact of Federal Research and Development Policies on Scientific and Technical Manpower, Hearings before the Subcommittee on Employment and Manpower, 89th Cong., 1st Sess., 1965, p. 44.

South Carolina, Georgia, and Florida, the percentage of Ph.D. production rose from 7.3 in 1940-49 to 8.8 percent in 1961-62, while the population increased from 12.9 to 14.5 percent, a shift in the ratio of Ph.D.'s to popula- from .57 to .61. In contrast, in the major doctorate-producing regions of the country, the East North Central region, the Middle Atlantic region, and the New England region, doctorate production in the same period declined.

Hornig attributed these shifts to federal research and development policies, stating, "I think that this kind of gradual change has been one of the most enduring accomplishments of our Federal research and development program."[1] He did acknowledge that the employment of Ph.D.'s varies considerably from region to region, but asserted that it is a mistake to claim that federal policies are primarily responsible for such variations. Before the period of large federal expenditures certain areas of the country for a number of complex reasons were industrially and scientifically strong.[2] When it became necessary to

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[1] _Ibid_., p. 44.

[2] For an analysis of some of the factors affecting industrial location, see Victor R. Fuchs, _Changes in the Location of Manufacturing in the United States Since 1929_ (New Haven: Yale University Press, 1962).

increase federal expenditures in such areas as defense and missiles, it was natural that contracts were placed where the skills were immediately available. "Arguments much like this apply to many other areas than R and D and all of this adds up to saying that the picture in a general way is not different than the concentration one finds in agriculture and many other national industries such as textiles, automobiles, steel, aluminum, chemicals, or petroleum." It is time that federal policies can affect the situation in some respects, but it would be a mistake to attribute more influence to federal activities than these activities actually have.

On the other hand, it is desirable to accelerate the process of making good universities available to talented people throughout the country. Here federal policies can have significant effects. The important question, however, is whether this goal can best be achieved through the mode of distribution of research money, or through some other means. The available evidence indicates that research funds alone cannot convert a mediocre university into a first-class one. General development funds initially are more important than research funds for general institutional improvement. Once a developing university attracts new faculty members it can then through the proposal system attract research funds. Finally, Hornig asserted, the question of the economic effects of research and development funds in universities is not yet well understood. It appears to be true that if an industry is located in the vicinity of a university conducting technologically useful research, industry can benefit from ready access to that research as well as from the presence of highly trained people. On the other hand, many first-rate universities that receive large quantities of federal research and development funds have not attracted technologically based industry to their vicinities.

In the conclusion of his statement, Hornig asserted that federal programs are not concentrating quality in a few universities.

> I believe that Federal funds available to everyone have improved the quality of education so that there are more good institutions and that they are spread all over the country in areas where good graduate education did not exist in the past. For this reason, although I feel we must do still more to equalize opportunity, I do not feel that drastic changes are needed today in the programs which have been so successful in the past.[1]

The Nelson hearings did not result in specific legislative proposals, although in a related matter, Senators Nelson, Clark, and Randolph on October 18, 1965, introduced a "Scientific Manpower Utilization" bill[2] to facilitate the use of scientific and technical resources in meeting social problems. This bill is discussed below in the context of a discussion of demands for support of "socially relevant" academic research.

The question of equity and inequity in the geographical distribution of academic research funds is only one aspect of the more general question of equity in the geographical distribution of all kinds of federal expenditures to states and regions. Several studies have analyzed

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[1] _Ibid_., p. 46.

[2] S. 2662, 89th Cong., 1st Sess., 1965.

the distribution of federal expenditures of all kinds among the states.[1]

Federal expenditures generally fall into six categories, although because of the complexity of federal programs these categories do not encompass all expenditures: (1) federal grants-in-aid to states and localities; (2) direct federal payments to individuals and non-profit institutions other than for wages and salaries; (3) federal civilian and military wages and salaries; (4) federal transfer payments to persons (social security); (5) procurement expenditures by the Department and Defense and the National Aeronautics and Space Administration, including research and development contracts between business and defense agencies; and (6) civil works of the Department of Defense and military reserve expenditures. It must be stressed that there are conflicts between sources of information on federal expenditures, and that information about many

[1]The most comprehensive studies are Selma Mushkin, Illustrative Estimates of Federal Expenditures and Revenues (Washington: U.S. Public Health Service, 1957); I. M. Labovitz, Federal Revenue and Expenditures of the Several States, Library of Congress, Legislature Reference Service (Washington: U.S. Government Printing Office, 1962); and U.S. Congress, Senate, Committee on Government Operations, Federal Expenditures to States and Regions, Report, Subcommittee on Intergovernmental Relations, 88th Cong., 2d Sess., 1964.

activities is not available.[1]

While there is no single national policy regulating federal expenditures by region, a substantial number of grants-in-aid have been made to state and localities,[2] particularly since the 1930's, in part to relieve financial strains on state and local governments. However, as Senator Muskie, the Chairman of the Subcommittee on Intergovernmental Relations of the Senate Committee on Government Operations, has pointed out:

> This assistance has largely taken the form of categorical grants whose distribution is limited by criteria which fail generally to consider their total economic impact on States or regions affected. . . . The impact of Federal spending on the economies of the several states or regions cannot be assessed merely by examining separate grant-in-aid programs or the total of Federal-aid payments. Other categories of Federal Government expenditure may have greater economic impacts. . . . Little attention has been paid to the possibilities for coordinating these broad sectors of Federal spending as policy objectives.[3]

For purposes of analyzing the question of the geographical distribution of federal expenditures,

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[1] See Dick Metzer, "Data for the Public-Finance Sub-Account," Elements of Regional Accounts, ed. Werner F. Hirsch (Baltimore: The Johns Hopkins Press, 1964), p. 92.

[2] See U.S. Congress, Senate, Committee on Government Operations, Catalog of Federal Aids to State and Local Governments, Report, Subcommittee on Intergovernmental Relations, 88th Cong., 2d Sess., 1964, and annual supplements.

[3] U.S. Congress, Senate, Committee on Government Operations, Federal Expenditures to States and Regions . . . , p. v.

expenditures can be classified in two general categories, expenditures made for the specific purpose of benefiting states and regions as an end in itself, and expenditures made as a means to some other end, such as the training of military personnel. Complications arise when an attempt is made to make expenditures simultaneously fulfill both objectives. The arguments advanced by those who advocate a wider distribution of federal academic research funds on economic grounds rest on the premise that academic research funds can and should be distributed in a manner designed to fulfill both of these objectives. These arguments usually rest on the additional premise that basic research funds, while of long-range significance to the achievement of mission objectives, are not spent for the purpose of bringing results of immediate usefulness to an agency, and thus can and should be distributed with some consideration given to the local economic effects of the expenditures. The evidence available indicates that basic research funds of some kinds often do not produce results of immediate usefulness to sponsoring agencies. The one major study of this question, the Department of Defense's "Project Hindsight," is a study of the sources of basic principles and technologies that have been incorporated into 20 weapons systems since 1945.[1] The first report of this study stated that in the systems studied the contributions from post-1945 research efforts were greatest when the efforts were specifically directed towards defense needs and that the basic science on which contemporary weapon systems are founded is on the order of 30 years old. In commenting on Project Hindsight, the editors of _Industrial Research_ observed:

> The gist of the total message is that basic research is not necessarily the boon to mankind that its promoters make it out to be. The view that basic research automatically contributes to society's goals is challenged. If the unoriented researcher wants money, he now will have to come up with something other than a call for faith in the future to gain public support for his hobby. . . . The significance of the Hindsight report should not be underestimated. It is more than a review of the genesis of 20 weapons systems. It is an example of a methodology applicable to the evaluation of other activities. The increasing use of program budgeting techniques

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[1] C. W. Sherwin and R. S. Isenson, _First Interim Report on Project Hindsight_ (Washington: Clearinghouse for Federal Scientific and Technical Information, 1966).

throughout the government will demand similar studies and they will be used to appraise basic research in other fields.[1]

Demands on economic grounds for "equity" in the distribution of federal academic research funds do have some basis in an emerging federal policy of encouraging economic growth through the support of basic research, and an emerging policy of taking into account the regional economic effects of federal expenditures in the formulation and administration of federal programs.

Since the enactment of the Employment Act of 1946, federal economic policy has been continuously re-examined and modified to promote national economic growth and, as one element of this objective, regional economic growth as well.[2]

A number of economists have attempted to analyze research and development as a component of economic

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[1] "'Hindsight' Foresight," Industrial Research, IX, No. 2 (February, 1967), 21.

[2] For a history of federal economic policy under the Employment Act of 1956, see U.S. Congress, Senate, Committee on Labor and Public Welfare, History of Employment and Manpower Policy in the United States, Twenty Years of Experience Under the Employment Act of 1946, Report of the Subcommittee on Employment and Manpower, 89th Cong., 2d Sess., 1966.

growth,[1] and the Council of Economic Advisors has stated that it regards federal support of research, particularly basic research, as an important element in national economic policy.[2]

In its 1964 report the Council asserted that technological change is one major element that contributes to economic growth, along with increases in the available quantity of the basic resources used in production improvements in the quality of labor as a result of better education

[1]See Edward F. Denison, The Sources of Economic Growth in the United States and the Alternatives Before Us (New York: Committee for Economic Development, 1962); Organization for Economic Co-operation and Development, Science, Economic Growth, and Government Policy (Paris: O.E.C.D., 1963); National Science Foundation, Proceedings of a Conference on Research and Development and Its Impact on the Economy (Washington: U.S. Government Printing Office, 1958); National Bureau of Economic Research, The Rate and Direction of Inventive Activity (Princeton: Princeton University Press, 1962); Richard R. Nelson, "The Simple Economics of Basic Scientific Research--A Theoretical Analysis," Journal of Political Economy, LXVII, No. 3 (1959), 297; Harry G. Johnson, "Federal Support of Basic Research: Some Economic Issues," in National Academy of Sciences, Basic Research and National Goals (Washington: U.S. Government Printing Office, 1965), p. 127; Richard R. Nelson, Merton J. Peck, and Edward D. Kalachek, Technology, Economic Growth, and Public Policy (Washington: The Brookings Institution, 1967); R. A. Solo, "Gearing Military R & D to Economic Growth," Harvard Business Review, XL, No. 6 (November-December, 1962), 49; Floyd A. Bond (ed.), Technological Change and Economic Growth (Ann Arbor: Michigan University Graduate School of Business Administration, 1965).

[2]Economic Report of the President, 1964, Together with the Annual Report of the Council of Economic Advisors (Washington: U.S. Government Printing Office, 1964), pp. 85-112.

and other factors, and reductions in cost resulting from expansion in the size of markets, or economies of scale. Basic research, in turn, is critically important to technological change because it is the primary source of new principles that underlie the development of new products and processes. The clearest case for public support applies to the more basic forms of research, because the incentives to industry to pay for this type of research are weak. This is so because an individual firm usually cannot recover the costs of research in its prices since the "product" of basic research is new knowledge, and scientific knowledge usually cannot be appropriated by one firm. Other firms and even other industries that did not incur the costs of the research can often share in the benefits.

> As a new development moves further along the research and development spectrum toward actual production, an individual firm may be able, through the patent system, to appropriate to itself rewards sufficient to justify the costs and risks of developing and introducing the new process or new product. The clearest case for public support thus applies to the more basic forms of research.[1]

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[1] *Ibid.*, p. 105.

Whether federal research support should be provided on a regional as distinguished from a national basis is, of course, a different question, but an assertion that support can and should be provided on a regional basis as a stimulus to growth underlies demands for "equity" in the distribution of academic research funds.

In addition to the emerging policy of encouraging economic growth through the direct support of research, there is also emerging at the federal level a policy of trying to spend federal funds in localities where growth is lagging, or in "labor surplus areas." One example of this incipient policy is in defense procurement. It is widely recognized that defense and space procurements can have substantial impacts on regional economies.[1] As a consequence, an attempt has been made to increase procurement in labor surplus areas through the use of preference mechanisms.[2] A study of these efforts concluded that

[1] See Roger E. Bolton, Defense Purchases and Regional Growth (Washington: The Brookings Institution, 1966), and works cited therein. See also, U.S. Arms Control and Disarmament Agency, Defense Industry Diversification, a report prepared by John S. Gilmore and Dean C. Coddington, University of Denver Research Institute (Washington: U.S. Government Printing Office, 1966).

[2] The history of these efforts is described in U.S. Congress, Senate, Committee on Small Business, Impact of Defense Spending in Labor Surplus Areas, 1962, Hearings, 87th Cong., 2d Sess., 1962.

> There has been little success by 1964 in the use of defense contracts to alleviate areas of persistent labor surplus. For fiscal years 1963 and 1964, these areas received 3.4 percent of procurement each year but preference awards accounted for less than 0.4 percent of total procurement in 1963, and only 0.5 percent in 1964.[1]

Many of the factors that have impeded the effort to diversify the distribution of procurement contracts are not as strong in the case of grants to universities for academic research. As described above, many witnesses before the Elliott, Daddario, and Nelson committees argued that agencies could and should exercise considerable flexibility in the distribution of academic research funds, particularly basic research funds, since these funds generally are not intended to procure services of immediate use to the agencies.

Those who demand a wider geographical distribution of academic research funds on economic grounds assert that academic research funds do, or at least can, have a stimulative effect on local and regional economic growth over and above the effects of funds spent for other purposes.

[1] Bolton, Defense Purchases and Regional Growth, p. 145.

The experience of Purdue University and other universities in the Midwest, however, indicates that a major university center heavily engaged in research does not always result in local economic growth.[1] Nonetheless, it is generally recognized that a university research center can contribute to economic growth under certain circumstances, and that research activities can have regional economic effects of unusual significance. Although regional economic studies are a relatively new field of investigation, a few studies have been directed to an analyses of the economic and social effects of research activity on local communities,[2] and at least two of these studies have analyzed the effects of academically based research on the area in which it is performed. The Elliott Committee examined the effects of government research and technical

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[1] On this point, see especially the testimony of Jean Paul Mather, a vice president of University City Science Center, Philadelphia, Pennsylvania, and the developer of an industrial research park affiliated with Purdue University, in Senate, Committee on Labor and Public Welfare, Impact of Federal Research and Development Policies . . . , pp. 208-22, and the statements of Albert Shapero, Stanford Research Institute, and Charles Kimball, Midwest Research Institute, pp. 493-520.

[2] These studies are summarized in the testimony given by Bowen C. Dees, Associate Director for Planning, National Science Foundation, to the Nelson Committee. See Senate, Committee on Labor and Public Welfare, Impact of Federal Research and Development Policies . . . , pp. 133-35.

centers on Huntsville, Alabama, and Tullahoma, Tennessee.[1] The committee noted that in many respects, such as employment and purchase of goods and services, research and development expenditures do not materially differ from other types of expenditures. However, on the basis of an examination of new business resulting from research and development activities, improvements in educational facilities, and other factors, the committee concluded that "There would indeed seem to be, in this instance at least, a difference in impact of dollars spent for research and development by the Federal Government, and of dollars spent by the Federal Government in other ways."[2]

The National Science Foundation is supporting a study of the economic impact of federal research and development funds on communities. The preliminary results of this study, as they relate to the effects of academic research funds, are as follows:

> A sizable local concentration of R and D usually has upgraded the quality of local education, both through the influence of researchers and their families as individual members of the community

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[1] U.S. Congress, House, Select Committee on Government Research, Impact of Federal Research and Development Programs, 88th Cong., 2d Sess., 1964, pp. 5-18.

[2] Ibid., p. 12.

> and through the demonstrated availability of interesting and well-paid jobs for those who can qualify through training. The interrelations of university education and R and D are quite varied, however. A university is a part of a cultural environment attractive to research professionals, though such an environment may exist without a university. Second, a local university may offer advanced training facilities for lower level research professionals. . . . Third, a university may contribute both to the initiation of local research, largely through the independent contributions of its faculty; and to the growth of a research complex, by providing advanced training, consultants, and research aids. This kind of university must be first rate in fields relevant to the local research community and one which allows or encourages a close interaction between university personnel and local research facilities. . . .
> A causal connection between the location of R and D and long-range economic growth, has to date not been proven. It is likely that a reciprocal relationship exists in many instances.[1]

On the basis of this and other studies, the National Science Foundation has taken the position that the role of research and development funds in the promotion of regional economic development is not clear.

> Although Federal funds for R and D can have a marked influence upon a local community, the extent and character of this influence depends upon both the nature of the R and D activity and of the community. The state of knowledge

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[1]Senate, Committee on Labor and Public Welfare, <u>Impact of Federal Research and Development Policies</u> . . . , pp. 134-35.

does not permit an unequivocal prediction that a particular activity will have multiplying and/or clearly beneficial effects upon a given community.[1]

The Stanford Research Institute has undertaken various studies of the research and development industry in the United States for the Department of Defense and NASA and as a part of these studies has investigated the economic impact of research and development expenditures.[2]

The Stanford studies initially concentrated on Denver, Colorado, Tucson, Arizona, and Orlando, Florida, and then shifted to several other cities and areas of the country. The preliminary results indicate that graduate research capabilities and extensive university research programs do not in themselves play a substantial role in

[1] Ibid., p. 135.

[2] Albert Shapero, Richard P. Howell, and James R. Tambaugh, An Exploratory Study of the Structure and Dynamics of the R & D Industry (Menlo Park: Stanford Research Institute, 1964); Albert Shapero, Richard P. Howell, and James R. Tambaugh, The Structure and Dynamics of the Defense R & D Industry: The Los Angeles and Boston Complexes (Menlo Park: Stanford Research Institute, 1965); Richard P. Howell, William W. Breswick, and Ernest D. Wenrick, The Economic Impact of Defense R & D Expenditures in Terms of Value Added and Employment Generated (Menlo Park: Stanford Research Institute, 1966); and Kirk Draheim, Richard P. Howell, and Albert Shapero, The Development of a Potential Defense R & D Complex (Menlo Park: Stanford Research Institute, 1966).

attracting industrial research and development to an area. Two other factors appear to be much more significant. The first is the presence of entrepreneurs who have the ability to couple scientific and technological knowledge with a realization of its economic implications, and who can translate knowledge into economically useful processes and products. The Boston and San Francisco areas, which are often cited as examples of areas that have benefited from the presence of research-oriented universities, afford many examples of this type of entrepreneur. In this context, the encouragement by universities of entrepreneural activity on the part of the faculty may be very important. The second factor of importance is the presence or absence in the regional banking and investment industry of a sophisticated and specialized knowledge of the economic potentials of research and development work, and the ability and willingness to finance such work. The Stanford studies indicate that the awarding of federal research and development contracts to an area, even over a period of many years, is not in itself sufficient to generate the type of research activity often considered to be of importance in the economic growth of a region. In addition to the presence or absence of these two factors, certain other economic and social factors seem to contribute to geographical concentration of research and development activities, particularly general population migration patterns. These patterns seem to persist in spite of such factors as the placement of defense contracts.

Another interpretation of the economic aspects of research and development activities has been expressed by Charles Kimball, the President of the Midwest Research Institute.[1] The Midwest Research Institute is a not-for-profit organization created in 1944 for the purpose of improving the economy of the Middle West through science and technology. Like other observors, Kimball has stressed the critical roles played by entrepreneurs and by local financial interests in effectively capitalizing on knowledge generated by academic research activity in a region. The critical realization is that the economy of the United States has since World War II made a major transition from

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[1] Senate, Committee on Labor and Public Welfare, Impact of Federal Research and Development Policies . . . , pp. 493-518.

its production orientation to an idea and service orientation. Research and development in general, and academic research in particular, can be important in capitalizing on this basic trend if a region can effectively link its academic research with "idea" industries, such as medicine, education, finance, and printing and publishing. Academic research will not produce economic growth in a region unless the research is related to problems and opportunities relevant to the economic development of the region.

> There has been much interest in various parts of the country in new research laboratories and new research institutes. A State's or region's economic development will not be enhanced just by starting and building institutions of this type. The economic result to the State will be determined totally by what is going on in these laboratories, its character, its purpose. Just to do research in an institute or university in a given State is no assurance of progress for that State.[1]

In summary, in the period 1963 to 1965 the Elliott, Daddario, and Nelson hearings provided forums for the defense of the existing distribution pattern, and for demands that the pattern be changed. The existing distribution pattern was generally defended by agency representatives and

[1] *Ibid.*, p. 516.

representatives of some of the more prestigious schools and established scientific groups on the grounds that this distribution pattern is a result of the allocation of funds on the basis of ability to perform quality research. The existing distribution pattern was criticized by representatives of some "have-not" institutions, and representatives of areas of the country that have had difficulty in obtaining large amounts of federal research and development funds. Almost all of the witnesses agreed that there is a need for a greater effort to create more "centers of excellence" than now exist, and that these centers should be located throughout the country. However, the critics of the present system would give much greater weight to criteria of geographical need than would defenders of the system. The logic of the critics of the present system is generally consistent with a change in emphasis from heavy reliance of the project system and quality criteria to broader forms of support based on criteria that measure the needs of regions for strong research institutions. The defenders of the existing system emphasize the importance of the scientific results of academic research. The critics place much greater emphasis on the values of research as a means of improving the quality of graduate education and as a means of stimulating regional economic development. The defenders of the system generally emphasize the importance of supporting the development of science through the support of meritorious individuals while the critics emphasize the importance of developing institutions to serve the regions in which they are located. Demands for "equity" in the distribution of funds are generally consistent with demands for the use of educational criteria in the administration of funds, which will now be considered.

The Demand for the Use of Educational Criteria in the Administration of Funds

The third major demand made on the federal academic research system in the 1960's is the demand that federal research funds be administered in a manner designed to benefit higher education. Whereas demands for wider geographical distribution of funds generally emphasize the possible social and economic benefits of academic research on the regions in which the research is performed, demands for the use of educational criteria in the allocation and administration of funds emphasize the possible educational benefits of research funds.

Demands for the use of educational criteria in the administration of funds usually take three forms: (1) demands for research funds for institutions not heavily engaged in federal research and science programs, including liberal arts colleges; (2) demands for flexible funds to enable institutions engaged in research to control their own developments, and to promote research in subject areas of interest to the institutions; and (3) demands for funds to enable institutions to "restore the balance" between teaching and research.

The basic issue posed by demands for the use of educational criteria in the administration of research funds is this: Should the project system with its emphasis on quality criteria and peer group judgment be maintained more or less intact, and supplemented by other forms of support designed to admit the relevance of educational criteria, or should the project system be modified to include the use of educational criteria in the allocation and administration of a large percentage of research funds?

Demands for changes in the existing system generally are predicated on the theory that universities have three basic functions: the acquisition of knowledge, which is the mission of research; the transmission of knowledge, which is the mission of teaching; and the application of knowledge, which is the mission of public service.[1] Demands for changes in the existing system generally rest on the assertion that federal support of research under the existing system has harmed higher education in two ways. In the institutions that have received large amounts of research funds it has led to an overemphasis on the research function, at the expense of the teaching and to some extent the public service function, particularly public service to meet civilian needs. In institutions that have not received substantial federal funds the existing system has harmed the performance of the research, teaching, and public service

[1]See James A. Perkins, _The University in Transition_ (Princeton: Princeton University Press, 1966), pp. 3-28.

functions because it has increased the difficulties of such institutions in competing for well-qualified faculty and students.

Charles Kidd has observed that the greater the stress placed on the educational functions of universities, the stronger the case becomes for shifting from the project system or from any system designed to support research to a system of broader forms of support based on the total needs of universities. Kidd has asserted that:

> The most important policy question arising from federal support of research in universities is whether the specialized aid should be broadened to, or supplemented by, general financial need to higher education.[1]

In the 1960's a number of statutes have provided various forms of aid to universities and colleges, such as the Higher Education Facilities Act of 1963,[2] the Health Professions Educational Assistance Act of 1963,[3] and the Higher Education Act of 1965.[4] However, as indicated in Chapter II, well over 70 percent of all federal funds

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[1]Kidd, American Universities and Federal Research, p. 112.

[2]P.L. 88-204, December 16, 1963, 77 Stat. 363, 20 U.S.C.A. 701-757.

[3]P.L. 88-129, September 24, 1963, 77 Stat. 164, 42 U.S.C.A. 292-294e.

[4]P.L. 89-329, November 8, 1965, 76 Stat. 1219, 20 U.S.C.A. 403 *et seq.*

allocated to higher education are funds for research or research-related activities. The question remains whether, or the extent to which, research programs should be designed and administered as a form of "aid to education."

For purposes of analysis, a research program can be distinguished from an "aid to education" program through the rough test of whether the program is designed and administered for the purpose of meeting the needs of an agency, or for meeting the needs of educational institutions. In some cases a program can meet both the needs of an agency and the needs of universities and colleges. The difficult problems arise when it is alleged that research programs do not meet the needs of universities and colleges, and in fact harm the structure of higher education in the United States. Can all research programs be designed to satisfy simultaneously the needs of the agency awarding the funds and the needs of higher education?

The standard position of the research funding agencies has been that it is difficult if not impossible to design all programs to simultaneously satisfy the needs of agencies and the needs of universities and colleges as a whole. Some conflict is bound to persist between the obligation of agencies to support research on a quality basis, and the needs of universities and colleges funds to meet the budgeting pressures caused by competition for quality faculty members, rising enrollments and other factors. In a report issued in 1958, the National Science Foundation asserted that:

> Problems of Government-university relationships in the Federal support of research at colleges and universities should be explicitly and completely disassociated from the budgetary needs and crises of the institutions and from the general issue of Federal aid to higher education. In the consideration and administration of these relationships there should be no implication that Federal sponsorship of research is a convenient subterfuge for Federal financial aid to institutions of higher learning.[1]

Demands for the use of educational criteria in the administration of research programs, although rarely cast in terms of "aid to education," frequently border on demands that agencies support universities and colleges outright because it would be in national interest to do so. In the past it has been politically wiser to request funds for

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[1]National Science Foundation, Government-University Relationships in Federally Sponsored Scientific Research and Development (Washington: U.S. Government Printing Office, 1958), p. 10.

universities and colleges in the name of "research" rather than in the name of "aid to education," at least in part because massive general aid to higher education by the federal government would violate the long tradition of the independence of higher education from federal support and "control."[1]

By asserting that federal research programs have harmed higher education, proponents of changes in the existing system argue for the inclusion of educational criteria in research programs as a means of correcting the harm done by the present system rather than as a means of directly aiding higher education. The essence of the argument is not that the federal government should aid higher education in the United States, but that the government should accept responsibility for correcting "inequities" and "inequalities" that have at least in part been created or maintained by its research programs. However, arguments of this kind often are difficult to distinguish from arguments for direct aid to education.

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[1]See, e.g., Rivlin, The Role of the Federal Government in Financing Higher Education; Babbidge, Jr., and Rosenzweig, The Federal Interest in Higher Education; Dobbins, Higher Education and the Federal Government.

The question of the impact of federal research funds on universities and colleges was the subject matter of several inquiries in the late 1950's and early 1960's, including the studies of Charles V. Kidd in 1959, Harold Orlans, 1962, the Carnegie Corporation in 1962, the Green Subcommittee in 1962, and the Elliott Committee in 1963. It remained for the House Committee on Government Operations, Research and Technical Programs Subcommittee, headed by Representative Henry S. Reuss of Wisconsin, to move into a political vacuum and to organize and systematically express the demands that the federal research system be changed to accommodate the needs of institutions of higher education.

The Research and Technical Programs Subcommittee was created in early 1965 as a response to the recommendation of the Elliott Committee that the House of Representatives create a standing committee to regularly examine federal research programs. As its first inquiry, the Reuss Subcommittee undertook an examination of conflicts between federal research programs and higher education. In addition to conducting hearings on the subject, the committee solicited by mail the views of 300 members of the academic and scientific communities, and conducted its own independent study of the relationship between federal research programs and higher education. The committee's report,[1] which was only partially based on the hearings and inquiries to the academic and scientific communities, asserted that federal research programs have harmed higher education in several significant ways and recommended several changes in the existing system. While most of the arguments and data set forth by the committee were not original with the committee, the committee's report was important because it organized arguments and data previously spread among many studies and reports. Labelling the committee's report a "devastating study," Daniel S. Greenberg observed:

> In recent years, especially in hearings before the various congressional committees that have been studying federal support of science, most of these arguments have been suggested or even shouted. The significance of their latest appearance is that they are concisely and powerfully presented in the subcommittee report, rather than strewn among a great deal of other material. . . .[2]

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[1]U.S. Congress, House, Committee on Government Operations, Conflicts Between the Federal Research Programs and the Nation's Goals for Higher Education, Report of the Research and Technical Programs Subcommittee, 89th Cong., 1st Sess., 1965 (hereafter cited as House, Committee on Government Operations, Conflicts Between the Federal Research Programs . . .).

[2]Daniel S. Greenberg, "R and D Boom: House Report Sees Harm to Higher Education," Science, CL, No. 3695 (October 22, 1965), 464.

While the committee has no legislative or appropriations authority over the agencies examined in its study, the committee's report served to focus demands for changes in the existing system.

The committee argued that federal research programs, on the one hand, and the nation's goals for higher education, on the other, are in conflict in three important ways.

The first is a conflict over the present use of scarce manpower. Scientists and engineers are indispenable to both research and teaching. Federal support of research to the exclusion of support of teaching diminishes the supply of available teachers in two ways. Many potential teachers find employment on federally-sponsored research projects in industry and in not-for-profit research institutions. In addition, teachers in universities are attracted away from teaching to work on federally-sponsored research projects carried on at universities.

The second conflict arises from the concentration of funds in a small number of prestigious institutions.

This concentration necessarily harms weaker and smaller institutions which cannot compete for well-qualified personnel.

The third conflict arises from federal support of research in the natural sciences to the virtual exclusion of support of research and scholarships in the social sciences and the humanities. Federal research programs have by their very nature contributed to imbalances between the natural sciences, and the social sciences and the humanities.

In somewhat greater detail, the committee's arguments were as follows. All students of the question agree that there is going to be a sharp rise in enrollments in universities and colleges in the late 1960's and 1970's. The Office of Education, for example, projects a doubling of the enrollment in 1960, 3,582,726, to 7,225,000 in 1970.[1] Working from 1964-65 figures, the Office of Education estimates that to meet an enrollment of 7,000,000 in 1970, the full-time equivalent of an instructional staff at colleges and universities will have to increase from 324,000 in

[1]See U.S. Department of Health, Education, and Welfare, Office of Education, _Projections of Educational Statistics to 1974-75_ (Washington: U.S. Government Printing Office, 1965), pp. 7-16.

1964-65, to 437,000 in 1970. In order to meet the required net increase of 113,000 teachers in this period, about 227,000 teachers will have to enter college teaching because of the need to replace those who die, retire, or go into other occupations. About 40 percent, or 90,000 of these new teachers should have a doctorate degree if teaching standards are to be maintained at about the present level. In 1963-64, 14,490 Ph.D.'s were awarded. If the number of these degrees increases at the long term average rate of 7 percent per year, the average yearly rate of increase throughout this century, then about 90,000 Ph.D.'s will be added in the period 1966-67. However, only about 48 percent of new doctorates go into college teaching.

While about 70 percent of new Ph.D.'s in the arts, humanities, and social sciences go into college teaching, only 41 percent do so in the biological sciences, 29 percent in physics, and 23 percent in chemistry. While it is dangerous to attribute these disparities to federal funding of research and development in industry and not-for-profit institutions, since the federal government supports around

70 percent of all research and development in the United States, it seems clear that federal support of industrial and other non-academic research contributes to the relatively low percentages of new Ph.D.'s in the sciences that go into teaching. A shortage of new Ph.D.'s in the physical sciences who go into teaching in the late 1960's and early 1970's is a virtual certainty.

In addition, university science teachers are diverted to research and from teaching within the higher education system by federal academic research funds. This is indicated in a gross way in the growth in higher education enrollment, teaching staff, and research staff in the period 1954-65. As indicated in Table 39, in this period enrollment increased by 114 percent, while teaching staff increased by 83 percent. In contrast, research staff increased by 217 percent. The result of these shifts is that each teacher averaged about 14 students in 1964 compared to 12.5 students in 1953. Of course, these figures do not indicate the concentration of research staff by institution and field. These figures, however, are a

TABLE 39

GROWTH IN HIGHER EDUCATION, ENROLLMENT, TEACHING STAFF, AND RESEARCH STAFF, 1954-1965
(thousands of persons)

Fall of Year	Enrollment	Full-time Equivalents of: Teaching Staff Total	Senior Staff	Junior Staff	Research Staff
1953	2,236	177	169	8	23
1954	2,452	189	180	9	25
1955	2,660	196	186	10	27
1956	2,927	216	205	11	30
1957	3,047	227	216	11	33
1958	3,236	234	222	12	35
1959	3,377	242	230	12	37
1960	3,583	251	238	13	43
1961	3,861	264	249	15	50
1962	4,175	282	266	16	57
1963	4,495	297	280	17	65
1964	4,775	324	305	19	73

Reprinted from U.S. Congress, House, Committee on Government Operations, Conflicts Between the Federal Research Programs and the Nation's Goals for Higher Education, Report of the Research and Technical Programs Subcommittee, 89th Cong., 1st Sess., 1965, p. 19.

gross indicator of the shift of university personnel from teaching to research. In addition, the committee stressed that many faculty members not classified as "research staff" spend a great portion of their time on research as distinguished from teaching. It noted that a reduction or even elimination of teaching load is one of the inducements used by well-financed institutions to secure quality personnel, and referred to the statement made in the course of the hearings by W. T. Lippincott, a professor of chemistry at Ohio State University who has made a study of the relationship between research and teaching in major universities, to the effect that:

> The present program for Government support of university research including the methods and policies for granting and administering funds, is at the same time the greatest benefit and also potentially the most powerful destructive force the higher education system in America has ever faced. Federal support has created opportunities for the evolution and advancement of human knowledge and for the stimulation of creativity far beyond the most prodigious expectations of our current senior scholars. . . . At the same time an imbalance between the effort at the graduate and undergraduate levels has arisen with the results that the talents of the undergraduate

> students are not being developed. Hence the supply of dedicated teachers, competent scientists, engineers, scholars, and well-informed citizens is being constrained dangerously due, in part, to the loss of the stimulation, guidance, and experience-inspired knowledge which traditionally has been passed on to the students by the research scholars.[1]

The committee argued that Clark Kerr, in his capacity of president of the University of California, probably expressed the view held by many educators when he observed in 1963 that:

> There seems to be a "point of no return" after which research, consulting, graduate instruction become so absorbing that faculty efforts can no longer be concentrated on undergraduate instruction as they once were. This process has been going on for a long time. Federal research funds have intensified it. As a consequence, undergraduate education in the large university is more likely to be acceptable than outstanding; educational policy from the undergraduate point of view is largely neglected. How to escape the cruel paradox that a superior faculty results in an inferior concern for undergraduate teaching is one of our more pressing problems.[2]

Federal research programs contribute to the deterioration in undergraduate teaching in two ways. At all except the wealthiest of the large research universities these funds attract both the best scientists and the best

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[1]House, Committee on Government Operations, Conflicts Between the Federal Research Programs . . . , p. 5.

[2]Clark Kerr, The Uses of the University (Cambridge: Harvard University Press, 1964), p. 65.

graduate students away from teaching. The wealthiest universities are better able than the poorer ones to hire additional staff, although even in these universities direct undergraduate exposure to the prestigious men in a field is often lost. Undergraduate colleges, particularly undergraduate liberal arts colleges, cannot compete with the great universities for quality teachers and necessarily suffer.

The committee also analyzed the concentration of funds and placed heavy emphasis on the fact that:

> The concentration of funds is not just in terms of the number of institutions, but also in terms of the type of institution supported. All of the top 54 recipients of Federal science funds are Ph.D.-granting institutions or advanced institutes of technology. Few could be described as representing smaller universities, and none are 4-year colleges awarding just the baccalaureate degree. This neglect of all sectors of higher education save the Ph.D.-granting institutions is confirmed by the National Science Foundation. . . . The NSF found that in fiscal 1963, 96 percent of all funds went to Ph.D.-granting institutions. Only 1 percent of the money went to 4-year colleges despite the fact that from 137 of these colleges, 25 percent of all science baccalaureates receive their degrees. Another 137 colleges and universities, responsible for about 14 percent of all master's degrees in science and engineering, received only 3 percent of the 1963 funds.[1]

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[1]House, Committee on Government Operations, Conflicts Between the Federal Research Programs . . . , p. 30.

The committee argued that federal funds are not yielding an adequate return in the training and education of scientists, and that the concentration of funds in a few major institutions clearly works to the detriment of other institutions in the higher education system. There is little evidence that federal research funds have contributed to the production of new Ph.D.'s in the natural sciences. Since 1900, doctorate production has on the average increased at a rate of 7 percent per year. However, from 1955 to 1960, the first period of the massive influx of federal funds to universities, the trend in doctorate production in the natural sciences declined. This trend was reversed in 1961, but the upsurge in the annual numbers of earned doctorates in the natural sciences has been accompanied by a similar surge in the social sciences and humanities, fields not heavily subsidized by federal funds.

> This strongly suggests that factors other than the flow of Federal funds to the sciences are responsible for a generally higher participation in graduate studies leading to the doctorate, and that these factors have affected the sciences and nonsciences alike.[1]

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[1] _Ibid_., p. 35.

Furthermore, the share of doctorates in the natural sciences has not increased proportionately to the share of the humanities and social sciences, despite heavy federal support of the natural sciences. Finally, the committee argued, there is little evidence that there is a close relationship between the volume of federal scientific research funds and the quality of science teaching at a given institution. While teaching quality is difficult to measure, one test is the percentage of students earning bachelor's degrees at an institution who receive prizes and awards for graduate study. For the period 1960-63, the American Council on Education computed extensive data on this question. Only 16 of the top 50 institutions in terms of percentages of awards received by students were among the major recipients of federal science funds. The University of California at Berkeley, Columbia University, and several other major recipients funds were not in the top 50, while 34 small liberal arts colleges that receive very small amounts of federal funds were on the list. In commenting on this fact, Kramer J. Rohfleisch, a professor of history at San Diego State College asserted:

> Few if any of these institutions possess departments which would be rated "distinguished" in terms of having men who have gained Nobel prizes or places in the National Academy of Sciences. None boast of enormous libraries, or even of elaborate equipment. But despite the lack of these badges of distinction, something is occurring which lies beyond the grasp of the great ones. They are teaching institutions. Their faculties perform their research too, but it is superimposed upon their task of teaching.[1]

Finally, the committee argued that the entire federal academic research funding system has harmed higher education by neglecting the social sciences and the humanities. It pointed out that in fiscal years 1963, 1964, and 1965, the physical sciences received about 69 percent of federal support, the life sciences about 28 percent, the social sciences about 2 percent, and other fields less than 1 percent. Such disparities result in lighter teaching loads for teachers in the physical sciences, and in many other benefits to natural scientists that are not enjoyed by teachers in other areas, such as grants for summer research projects. In addition, the committee noted that

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[1]U.S. Congress, House, Committee on Government Operations, _Responses from the Academic and Other Interested Communities to an Inquiry by the Research and Technical Programs Subcommittee_, 89th Cong., 1st Sess., Part 2, p. 515.

federal policies seem to reinforce the tendency to regard science as the most desirable form of inquiry, and pointed particularly to the undesirable aspects of having to justify social inquiry in terms of methods derived from the natural sciences. It quoted David Riesman's statement to the committee that:

> It is not so much that the "hard science" departments are being supported, but that the "hard" outlooks are being supported within every field, including the humanities. The academic judgments as to what is "research" and the judgments is to what are the appropriate methods for discovery, tend to become stereotyped as the result of the anxieties of young researchers lest they not be pursuing the approved formulas. . . . Throughout American life, and not only in the academic and research world, there is a search for easily grasped standards of performance which avoid the making of difficult qualitative judgments.[1]

On the bases of these and related arguments, the Reuss Committee recommended several changes in the existing research support system. The committee stated that the project system is and should remain the backbone of the entire federal research support system. However, the committee asserted that in the future the criteria of quality usually relied upon in making grants should be supplemented

[1] *Ibid*., p. 389.

by criteria designed to increase the quality of science education at institutions where the research is to be carried on. While excellent research projects should continue to be supported at prestigious institutions, a good proportion of the project money in the future should be awarded on the basis of the contribution of the project to both graduate and undergraduate education. Proposals should first be evaluated on the basis of merit by groups of scientists. They should then be evaluated by administrators applying educational criteria, such as the needs of the department of the university with which the proposant is affiliated, the number of students that might work on and benefit from the grant, and similar factors. The use of educational criteria should not be on an "other-things-being-equal" basis. "Improvements of science education should be a major goal of all project award programs and, accordingly, effects of a project favorable to science education should often be of decisive importance."[1]

The committee asserted that a vigorous effort should be made to award modest project funds to faculty members

[1] House, Committee on Government Operations, Conflicts Between the Federal Research Programs . . . , p. 48.

who are primarily interested in teaching, but wish to participate in research on a modest level. Teachers should not be penalized because they do not have a great deal of time to devote to research, and for this reason awards should not be made solely or even primarily to those who can state in their applications that they have substantial amounts of time to devote to projects.

> What is to be gained if a basic research project is completed in 1 year by a scientist with a minimal teaching load at a large university rather than in 2 years by a scientist with a heavier teaching load at a college or small university? In basic research devoid of immediate mission and far removed from the time pressures of high priority development programs, time is not of the essence.[1]

Since the project system is the system used by all the major agencies to fund academic research, all of the agencies should place increased emphasis on educational aims by use of educational criteria in the selection of projects. In addition, project awards should be distributed over a wider geographic area, with emphasis on the needs of institutions not now receiving substantial amounts of funds. The committee argued that the use of

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[1] *Ibid.*

educational and geographic criteria would not necessarily lead to the support of inferior work. In this connection it cited NSF's statement that in 1964 more than one-half of about 2,915 proposals that were declined or withdrawn were meritorious ones, many of them from smaller schools "where an award would have given valuable impetus to the scientific program at the institution and where a declination almost surely had a most discouraging impact."[1]

In addition to alterations in the project system, the Reuss Committee recommended substantially greater use of institutional grants by all of the major agencies. The committee made this recommendation on two grounds. First, large institutions undoubtedly will continue to receive a higher proportion of project grant funds than smaller institutions. Many smaller institutions cannot effectively compete for project funds at the present time because of lack of scientific personnel, clerical personnel, and research equipment. Institutional grants are needed to build a minimum scientific base in such institutions. Other institutions that intend to devote their

[1]National Science Foundation, Fourteenth Annual Report, 1964 (Washington: U.S. Government Printing Office, 1965), p. 97.

primary energies to teaching need funds to increase their staffs so they can offer teachers some time for research, and procure equipment for laboratory instruction. Second, institutional grants are necessary to enable institutions heavily engaged in research to exercise control over the direction of their research. Many institutions receive from 70 to 90 percent of their research funds from project awards.

> Research is conducted in scientific areas chosen by the individual investigator. Under such an anarchic system gaps are created between projects, and important scientific areas left relatively underdeveloped at the institution. There is consequently a need for an appreciable amount of unfettered funds to be given universities to fill the interstices between disparate project research activities.[1]

Finally, the committee asserted that institutional grants should be awarded on the basis of two standards. The first standard is the volume of project grants presently received by an institution. A fixed percentage of project grant funds should be awarded in addition to the project funds in the form of free funds to be used by the institutions for general research purposes. This type of grant

[1] House, Committee on Government Operations, Conflicts Between the Federal Research Programs . . . , p. 52.

would enable institutions heavily engaged in research to exercise control over their own developments. All agencies should make this type of grant. The second standard should be the number and percentage of bachelors of science from a given institution who enter graduate school. This standard would help to deconcentrate federal research support by distributing funds to institutions heavily engaged in the production of baccalaureates in science.

Finally, the Reuss Committee concluded that all agencies should encourage researchers to teach by removing restrictions on teaching from contract and grant instruments and by stipulating that recipients of fellowships, research assistantships, and traineeships devote a portion of their time to undergraduate teaching when the need exists. The major agencies should also institute programs of science teaching fellowships in fields related to the agencies' missions, with stipends at least as large as those available in fellowships and traineeship programs.

Whatever the merits of the arguments and recommendations of the Reuss Committee, the work of this committee indicates two significant things. From a political viewpoint, it has become worthwhile to demand changes in the federal research system to accommodate the educational needs of universities and colleges, particularly the "have not" institutions. From a policy viewpoint, the federal academic research funding system has become too massive, and has too many effects on higher education in the United States to be administered with only incidental weight given to educational factors, such as the diversion of teachers from research to teaching, or the needs of institutions for funds to regulate their own developments. The Reuss Committee's report constitutes an attack on the traditional rationale of federal support of academic research as it was set forth, for example, by the Committee on Science and Public Policy of the National Academy of Sciences in its report, _Federal Support of Basic Research in Institutions of Higher Learning_. According to the National Academy of Science's Committee, the basic rationale of federal support of academic research has been and should be the potential benefit to an agency and to the nation of the _results_ of research of high quality. The basic decisions on the research to be supported should be made by scientists, because they are the only ones qualified to judge the merits of the research proposed. The Reuss Committee challenged this line of thinking, and instead argued that the rationale underlying federal support should be not only the potential benefits of the results of quality research but also the more immediate benefit of the conduct of research on students and higher education as a whole. Those who support the Reuss line of thinking would supplement or replace the judgments of scientists on the research to be supported with the judgments of federal and university administrators. They would move strongly in the direction of converting the academic research funding system into a system designed in good part to aid the development of higher education in the United States.

The Demand for the Application of Science to Social Needs

The fourth major demand made on the federal academic research system in the 1960's has been the demand for more extensive efforts to apply science to the satisfaction of social needs. This demand has taken two general forms, demands that funds be allocated to fields and subject areas of basic research, in part, on the basis of the potential relevance of fields to the satisfaction of social needs, and demands that the government support more applied research directly oriented to the satisfaction of social needs. These demands have been expressed in a number of ways, including (1) a proposed change in the organic Act of the National Science Foundation to authorize the Foundation to support applied as well as basic research,[1] (2) a presidential injunction to NIH to find ways to apply the results of biomedical research more rapidly and more widely,[2] (3) an increased emphasis on the transfer of technology to industry, through programs of the Department

[1]See Emilio Q. Daddario, "A Revised Charter for the Science Foundation," _Science_, CLII, No. 3718 (1966), 42; Dael Wolfle, "Transforming the National Science Foundation," _Science_, CLII, No. 3724 (1966), 869; U.S. Congress, House, Committee on Science and Astronautics, _Review of the National Science Foundation_, Hearings before the Subcommittee on Science, Research, and Development, 89th Cong., 1st Sess., 1965, and U.S. Congress, House, Committee on Science and Astronautics, _A Bill to Amend the National Science Foundation Act of 1950_, Hearings before the Subcommittee on Science, Research, and Development, 89th Cong., 2d Sess., 1966.

[2]See John Walsh, "NIH: Demand Increases for Applications of Research," _Science_, CLIII, No. 3732 (1964), 149.

of Commerce, NASA, and other agencies,[1] (4) an increased emphasis by the Office of Science and Technology and other agencies and offices on problems such as air pollution and environmental control,[2] (5) an increased emphasis on the concept of urban-research oriented programs,[3] (6) an increased emphasis on the concept of applying some form of "systems analysis" to problems of a civilian nature, such as transportation,[4] and (7) an increased emphasis on such

[1]See U.S. Congress, House, Committee on Interstate and Foreign Commerce, State Technical Services Act of 1965, Hearings before the Subcommittee on Commerce and Finance, 89th Cong., 1st Sess., 1965, and John Walsh, "Technical Services Act: Industry to Benefit from New State Programs Paralleling Farm Extension Service," Science, CXLIX, No. 3691 (1965), 1485.

[2]See President's Science Advisory Committee, Restoring the Quality of Our Environment (Washington: The White House, 1965). See also, Walter E. Sullivan, "What Man Does to the Planet," New York Times, January 1, 1967, p. E7.

[3]See, e.g., New York Times, "Rebirth of Cities Urged by Ribicoff: He Proposes 'Urban Action Centers' at Universities," December 12, 1966, p. 31. See also, Fred M. Hechinger, "The University as a Problem for the City, and Vice Versa," New York Times, December 11, 1966, p. E7.

[4]See U.S. Congress, Senate, Committee on Labor and Public Welfare, Scientific Manpower Utilization, 1965-66, Hearings before the Special Subcommittee on the Utilization of Scientific Manpower on S. 2662, a Bill . . . to Employ Systems Analysis . . . to Solve National Problems," 89th Cong., 1st and 2d Sess., 1965, 1966, and U.S. Congress, House, Committee on Government Operations, The Federal Research and Development Programs: The Decisionmaking Process, Hearings and Report of the Research and Technical Programs Subcommittee, 89th Cong., 2d Sess., 1966. See also, Luther J. Carter, "Systems Approach: Political Interest Rises," Science, CLIII, No. 3741 (1966), 1222, and John P. Eberhard, "Technology for the City," International Science and Technology (September, 1966), p. 18.

potentially useful areas of inquiry as oceanography.[1]

The studies of the National Commission on Technology, Automation, and Economic Progress are another indication of the extent of concern over the question of whether science and technology have been managed and applied as effectively as possible for the realization of social ends.[2]

Underlying these demands are profound[3] and what many scientists consider dangerous[4] shifts in the expectations brought to research programs by members of various groups interested in federal academic research programs. From the inception of federal support of academic research

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[1]See, e.g., National Academy of Sciences--National Research Council, Economic Benefits from Oceanographic Research (Washington: National Academy of Sciences--National Research Council, 1964); Luther J. Carter, "Sea-Grant Colleges," Science, CLII, No. 3727 (1966), 1358; President's Science Advisory Commission, Effective Use of the Sea (Washington: U.S. Government Printing Office, 1966).

[2]See, in particular, National Commission on Technology, Automation, and Economic Progress, Technology and the American Economy, Appendix, Vol. V; Applying Technology to Unmet Needs (Washington: U.S. Government Printing Office, 1966).

[3]See, e.g., Daniel S. Greenberg, "Basic Research: The Political Tides are Shifting," Science, CLIII, No. 3720 (1966), 1724; Walter E. Sullivan, "Drift from 'Pure Science,'" New York Times, July 3, 1966, p. 8E.

[4]See Walter E. Sullivan, "Scientists Fear Domination by Politics," New York Times, October 23, 1966, p. 1, col. 3. For a thorough analysis of theories of the proper relationship of science to society, see Michael Polanyi, Personal Knowledge (Chicago: University of Chicago Press, 1958).

there has been a tension between support of applied research, or research directed to some specific end determined by considerations other than the desire to advance science as a worthy end in itself, and basic research, or research undertaken for the primary purpose of advancing scientific knowledge as a self-contained objective. Vannevar Bush observed in _Science, the Endless Frontier_, in 1945, that:

> The distinction between applied and pure research is not a hard and fast one, and industrial scientists may tackle specific problems from broad fundamental viewpoints. But it is important to emphasize that there is a perverse law governing research: under the pressure for immediate results, and unless deliberate policies are set up to guard against this, applied research _invariably drives out pure_. This moral is clear: It is pure research which deserves and requires special protection and specially assured support.[1]

It could be argued that the experience of the Office of Naval Research since World War II exemplifies the principle set forth by Bush: applied research drives out basic.[2] ONR, which was the leader in the support of basic research immediately after World War II, in the last twenty years has moved more and more towards the support of "mission

[1] Bush, _Science, The Endless Frontier_, p. xxvi.

[2] See Luther J. Carter, "Office of Naval Research: 20 Years Bring Changes," _Science_, CLIII, No. 3734 (1966), 397.

relevant" or applied research. At the twentieth anniversary convocation of the agency, held in July 1966, Harvey Brooks, the chairman of the National Academy of Sciences' Committee on Science and Public Policy, expressed the fear that throughout the federal government "mission relevant" research will be overstressed in the future, to the harm of American basic science. Brooks asserted that "Perhaps for the first time since the war, the assumptions on which our science policy of the past 20 years has been based are being seriously questioned and even challenged."[1]

The basic assumption referred to by Brooks can be stated as follows. Basic research should be supported for its potential contribution to social welfare, as well as an end in itself, because advances in basic science underlie the development of many socially useful processes and projects in medicine, in communications, in defense, in energy resources, and in innumerable other areas of social and economic development. However, specific basic research projects should not be supported with the expectation that immediate and identifiable results will be produced. The

[1] *Ibid.*, p. 398.

results may not be significant except to disprove unsound theories, or the results may be significant, but the significance may not be realized for some time. Furthermore, the history of research indicates that research in one area of inquiry may have totally unexpected consequences in other areas.[1]

In any case, it is difficult if not impossible to foresee the results of basic research. For this reason, it is dangerous to limit the support of research to areas or topics in which the results may be expected to be socially relevant.

The nation through federal agencies should support the expansion of basic research capability, without demanding immediate benefits from such support. While it is desirable to extend research capability as broadly as possible, support should first be given to established researchers and institutions. Decisions on who should and should not be supported should be made by scientists themselves, because only scientists are competent to judge the merit of a man's work. Daniel S. Greenberg has summarized

[1]See, e.g., R. Taton, Reason and Chance in Scientific Discovery (New York: Science Editions, 1962). See also, Barber and Hirsch (eds.), The Sociology of Science, Part 5, pp. 477-557.

the administrative implications of these assumptions as follows:

> In a formal sense, the system of support was tied into the traditional political process of agency proposals, executive reviews, and congressional approval; but, at least as far as basic research was concerned, the working truth of the system was that the federal government turned tax funds over to the scientific community, and the community, through an elaborate apparatus for appraising and bargaining, allocated the funds among competing applicants. The system, the federal politicians were told, could not successfully operate in any other fashion, because science, to be fruitful, must be governed by scientists.[1]

In contrast to the assumptions on which the federal academic research funding system has been based, it is possible, of course, to formulate an entirely different set of "assumptions" or principles. These assumptions can be summarized as follows. Federal support of research, like federal support of any other activity, should be undertaken for the attainment of politically defined purposes. Federal support of undirected, basic research in universities is made for the purpose of advancing American science, because science has proven to be of value both as an intellectual activity and as a means to other ends. However, the

[1] Greenberg, "R and D Boom: House Report Sees Harm to Higher Education," Science, CL, 464.

objective of advancing science is only one of many objectives that should be sought by federal action. The evidence available indicates that in the 1960's American basic science is well developed and well supported. The level of federal investment in science qua science is high and should be maintained. However, one of the consequences of this high level of support has been the production of new scientists who may expect to be supported as well as their teachers have been supported in the past. Another result of this high level of support has been to generate demands for federal funds for large, expensive facilities for basic as well as for applied research.

There is good evidence that the demands from particular scientific disciplines for federal support of science qua science in the future will become more intense.[1]

Thus, the Committee for the Survey of Chemistry of the National Academy of Sciences concluded in 1965 that a 16 percent per year increase in federal funds for the support of chemistry as a discipline would be inadequate. The committee asserted that:

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[1]See Daniel S. Greenberg, "Money for Science: The Community is Beginning to Hurt," Science, CLII, No. 3728 (June 10, 1966), 1485.

> The Committee feels strongly that even a 16 percent rate of increase will prove inadequate to achieve the proper growth of U.S. chemistry. The data in this report have provided evidence that financing in the past has led to the present situation, in which numerous active research chemists--and especially the younger ones in universities--are unable to exploit their ideas.[1]

Like most other aid systems, the research funding system appears to be generating demands on itself. If supplies of funds and of manpower were unlimited, the federal academic research support system could be expanded indefinitely along present lines. However, both funds and manpower are limited. Furthermore, it is by no means clear that all of the basic research that is supported is worthwhile. Daniel Greenberg observed in June 1966, that:

> One strand of political feeling that now seems to be developing toward federal support of basic research is reminiscent of what John Wanamaker is reputed to have said of his advertising budget--namely, he knows that 50 percent is wasted, but he doesn't know which 50 percent.[2]

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[1] National Academy of Sciences, National Research Council, Chemistry: Opportunities and Needs, A Report on Basic Research in U.S. Chemistry by the Committee for the Science of Chemistry (Washington: National Academy of Sciences, National Research Council, 1965), p. 188.

[2] Greenberg, "Money for Science: The Community is Beginning to Hurt," Science, CLII, 1486.

At the same time, a variety of social needs may in part be susceptible to analysis through research. These needs are at least as pressing as the needs of researchers for funds to freely explore their ideas. The best solution for meeting the needs of researchers for funds and the needs of society for research on problems such as air pollution is to increase the number of applied or directed research programs, rather than to provide substantially greater funds to researchers for undirected research through the project system.

In analyzing the question of federal support of academic research it is customary to distinguish between research done to promote the advancement of science itself, and research done to achieve some other objective of government, such as control of the environment.[1]

Demands for the application of science to social needs, of course, stress the idea of using science rather than merely supporting it. From positions within the scientific community, both Alvin Weinberg, the director of the Oak Ridge National Laboratory, and Edward Teller,

[1]See, e.g., Weinberg, "Scientific Choice, Basic Science, and Applied Missions," in National Academy of Sciences, Basic Research and National Goals, pp. 279-87.

have argued that in the long run the welfare of science may best be promoted by an explicit recognition on the part of scientists that it is desirable to admit the relevance of criteria of social need when formulating national research support policies. Weinberg has argued[1] that the criteria for the support of research are of two kinds, internal and external.

The internal criteria are the readiness of a given field for exploitation, in the judgment of scientists, and the competency of workers in the field. The external criteria are the technological, scientific, and social merits of the proposed research. While the internal criteria are important, it is a serious mistake to believe that they are more important than the external criteria.

[1]Alvin M. Weinberg, "Criteria for Scientific Choice," Minerva, I (Winter, 1963), 165. See also, John Maddox, "Choice and the Scientific Community," Minerva, II (Winter, 1964), 141; Stephen Toulmin, "The Complexity of Scientific Choice: A Stocktaking," Minerva, II (Spring, 1964), 343; Alvin M. Weinberg, "Criteria for Scientific Choice II: The Two Cultures," Minerva, III (Autumn, 1964), 3; Alvin M. Weinberg, "Scientific Choice and Biomedical Science," Minerva, IV (Autumn, 1965), 3; and Stephen Toulmin, "The Complexity of Scientific Choice II: Culture, Overheads or Tertiary Industry," Minerva, IV (Winter, 1966), 155.

> It is not tenable to base our judgments entirely on internal criteria. As I have said, we scientists like to believe that the pursuit of science as such is society's highest good, but this view cannot be taken for granted. . . . Society does not a priori owe the scientist, even the good scientist, support any more than it owes the artist or the writer or the musician support. Science must seek its support from society on grounds other than that the science is carried out competently and that it is ready for exploitation; scientists cannot expect society to support science because scientists find it an enchanting diversion. Thus, in seeking justification for the support of science, we are led inevitably to consider external criteria for the validity of science--criteria external to science, or to a given field of science.[1]

The external criterion of technological merit is not particularly difficult. Once a certain technological end is judged to be worthwhile, the task is to support the research necessary to achieve it. The external criterion of scientific merit is essentially the contribution that research in one field of science may make to related scientific fields. The criterion of social merit is the most difficult one of all, since it concerns the questions of human welfare and social values. Despite the difficulties of reaching agreement on these values through political and

[1] Weinberg, "Criteria for Scientific Choice," Minerva, I, 165.

other processes, the basic point is that this criterion should be recognized as a valid one in making decisions on what types of research to support.

> It is as much out of a prudent concern for their own survival, as for any loftier motive, that scientists must acquire the habit of scrutinizing what they do from a broader point of view than has been their custom. To do less could cause a popular reaction which would greatly damage mankind's most remarkable intellectual attainment--modern science--and the scientists who created it and must carry it forward.[1]

Weinberg's argument is important because it goes beyond the standard argument offered by those who favor the support of science qua science, such as the argument advanced by the Committee on Science and Public Policy of the National Academy of Sciences in Federal Support of Basic Research in Institutions of Higher Learning. The essence of the traditional argument is that science is a self-contained intellectual and social system, with its own internal logic and norms. Government, when supporting basic research, should support science on its own terms. The decisions on the areas of research to be supported should be made by scientists using criteria

[1] *Ibid.*, p. 171.

devised from the internal logic of science itself. Weinberg's argument is significant because it asserts that, even in the case of basic research, the allocations to various disciplines and to various subject matter areas should be made in part on criteria of potential social relevance. Thus, in deciding on the size of allocations to high energy physics and to behavioral science, it is relevant to consider what the needs of society may be in the foreseeable future. It is possible that more substantial social advances may be made through the support of behavioral science than through the support of high energy physics. This possibility should be considered in attempting to set priorities for support.

Edward Teller has also argued that social need should be taken into consideration in the allocation of funds to academic research. However, while Weinberg has stressed the relevance of social need in making allocations for basic research, Teller has argued that there is a need in the United States to strengthen the role of research and education in applied science.[1]

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[1]Edward Teller, "The Role of Applied Science," in National Academy of Sciences, Basic Research and National Goals (Washington: U.S. Government Printing Office, 1965), pp. 257-66. See also, Arthur Kantrowitz, "Leadership in Applied Physical Science," in National Academy of Sciences, Basic Research and National Goals, pp. 143-46.

Teller has argued that since World War II both pure science, on the one hand, and engineering, on the other, have been reasonably well supported. Pure science, in Teller's use of the term, is concerned with the discovery of new facts and the understanding of nature without expectations of practical applications. It is guided by value judgments concerning the interests in various scientific fields. Pure science is the first phase in the total structure of science and technology, while engineering is the last phase. In the engineering phase the feasibility of a project is assured. The basic questions remaining relate to the effective, economical, and safe execution of a project. Applied science occupies a position between pure science and engineering. Applied science is undertaken with a definite, practical aim in mind, but with no assurance that the aim can be achieved. While the methods used in pure science and applied science often are similar, there also are important differences. Applied science often requires the cooperation of experts from different fields, and usually requires more management than pure science. Applied science imposes a different style of work, with considerably more emphasis on meeting time schedules and similar factors.

American universities have generally concentrated on pure science on the one hand, and engineering on the other. "In our educational institutions applied science may almost be described as 'no man's land.'" If American science is going to be put to more effective social use in the future, the universities will have to strengthen their efforts in education for applied science.

> Our university departments tend increasingly to emphasize specialization. While this trend helps in many branches of pure science and also is useful in engineering developments, it has a decidedly harmful effect in applied science.[1]

The policy implications of Teller's position are that government should support education and research in applied science in universities. One way in which this can be done is to encourage cooperative undertakings between universities and federal research installations, as has been done by the Atomic Energy Commission and the National Aeronautics and Space Administration.

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[1] Teller, "The Role of Applied Science," in National Academy of Sciences, Basic Research and National Goals, p. 264.

While Weinberg and Teller speak from within the scientific community, many of the demands for more extensive efforts to apply science to the satisfaction of social need have come from the President and his science advisors, and from Congress. In the 1950's the predecessors of the President's Science Advisory Committee and the Office of Science and Technology (OST) devoted most of their time to matters of defense. In the 1960's, PSAC and OST have become increasingly involved with problems of a civilian nature.[1] The report of the Environmental Pollution Panel of the President's Science Advisory Committee, for example, constitutes the most thorough examination of the problem of environmental pollution yet undertaken at the policy level.[2] The political influence of these agencies, however, is limited by their dependence on the President for the implementation of their suggestions. In the 1960's, President Johnson, both in his speeches[3] and his directives to

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[1]For a discussion of this change in emphasis, see the statement of Donald F. Hornig, Director of the Office of Science and Technology, in U.S. Congress, Senate, Committee on Appropriations, Independent Offices Appropriations for Fiscal Year 1967, Hearings, 89th Cong., 2d Sess., 1966, Part 2, pp. 1161-1195.

[2]President's Science Advisory Committee, Restoring the Quality of Our Environment (Washington: The White House, 1965).

[3]See, e.g., Douglas Kiker, "Johnson Appeal: Let Science Serve World," Herald Tribune, June 11, 1964, p. 2, cols. 2-5.

agencies,[1] has stressed the importance of not only supporting but also of applying science to the satisfaction of social needs, although Elmer Staats, Deputy Director of the Bureau of the Budget, has publicly acknowledged that the Vietnam War has impeded the Johnson Administration's efforts in this direction.[2]

The two movements towards the application of science to social needs with the greatest implications for the funding of academic research by federal agencies are the movement to amend the National Science Foundation Act, and the movement to apply "systems analyses" to social problems through reliance, in part, on academic research efforts. Both of these movements have originated in Congress.

The movement to amend the National Science Foundation Act arose out of the extensive hearings on the Foundation by the Daddario Committee in 1965.[3] These

[1] See Walsh, "NIH: Demand Increases for Applications of Research," _Science_, CLIII, 149.

[2] U.S. Congress, House, Committee on Government Operations, _The Federal Research and Development Programs: The Decisionmaking Process_, Hearings, 89th Cong., 2d Sess., 1966, pp. 9-10.

[3] U.S. Congress, House, Committee on Science, Research, and Development, _Government and Science: Review of the National Science Foundation_, Hearings before the Subcommittee on Science, Research, and Development, 89th Cong., 1st Sess., 1965.

hearings, which extended over a two-month period, were designed to answer three questions: (1) How well has NSF performed the tasks assigned to it in the basic Act of 1950? (2) What roles, responsibilities, and missions should NSF assume in the future? (3) What legal and financial tools will NSF need in the future to accomplish its work? As a result of the extensive testimony given before the committee, the committee concluded:

> Fundamentally it may be said that the Foundation has functioned, and still does, in a manner that is largely passive. It has not itself put a sustained effort into developing substance, form, and direction of the programs it supports. Once granted its annual budget, NSF has to a large extent followed a practice of waiting for talented outsiders to suggest appropriate projects on which to spend it.[1]

The committee recognized that there have been good reasons for NSF's passivity. A passive role is particularly appropriate in the support of basic research, where ideas must originate in the minds of investigators. Furthermore, NSF's charter generally does not authorize in-house research or technological activity on the part of the agency. This passivity to some extent has enabled NSF to avoid pressures

[1]U.S. Congress, House, Committee on Science and Astronautics, The National Science Foundation, Its Present and Future, Report of the Subcommittee on Science, Research, and Development, 89th Cong., 1st Sess., 1966, p. xii.

generated by national political processes.

> The Foundation has been relatively free from the pressures that can be experienced by Federal agencies as the national political process reconciles different interests of national regions, States and districts. NSF decisions have been based upon the needs of the academic community without having to consider the needs and interests of other sectors of our society.[1]

While NSF did function effectively to meet the needs that were apparent in the period 1950-65, that period is over. The time has come for NSF to assume a more positive, dynamic stance. There are three reasons why this is so. The first reason lies in the problems posed by man's destruction of his environment.

> The problems of living in today's environment are reaching proportions which are truly monumental. It is conceded that they will not be solved without an equally monumental lift from science and technology. Foundation guidance in focusing upon applied areas of appropriate research and education could be a major factor in maintaining the stability of a civilization which is today seriously threatened by the surfeit and concentration of people and their problems.[2]

The second reason NSF should become more dynamic in its activities is that NSF is the only federal agency

[1] *Ibid.*, p. 28.　　[2] *Ibid.*, p. xii.

with an exclusively scientific mission. More than any other agency, it is in a position to cooperate with the President and his science advisors in the formulation of something resembling a national science policy.

Finally, as the demands increase for the application of science to social needs, it will be necessary for some agency to provide support of research and science activities in areas in which other agencies fail to do so. The Foundation is the logical agency to do so. This role of the Foundation will not be limited to the natural sciences, but will extend to the social sciences as well.

The committee concluded that NSF's organic Act should be amended to authorize the Foundation to support applied research in areas related to national goals, to explicitly authorize NSF to support the social sciences, and to increase the international responsibilities of the Foundation. The committee also recommended several organizational changes.

On March 16, 1966, Representative Daddario introduced in the House, H.R. 13696, a bill designed to effect the changes recommended in the committee's report. In an article published in *Science* on April 1, 1966, Representative Daddario explained that the bill was not designed to convert NSF into an applied science agency.[1] He stressed that:

> The legislation provides for the Director to support *some* applied research or engineering, at his discretion, in areas where research appears promising in regard to the alleviation of a basic national problem. The bill does not *direct* NSF to undertake such research, and it should not be regarded as a move to put NSF generally into the field of applied research and development. . . . What is intended is that the Foundation be permitted to support research of this kind where national need is great enough to justify it, where the research field involved is not adequately being investigated by others, and, even then, to pursue it only to the point where other agencies or private parties may take up the endeavor and develop it further.[2]

He also stated that one of the purposes of the bill is to channel more effort into the social sciences because the social sciences may ultimately hold promise for the resolution of social problems.

In the hearings on the Daddario Bill, at which only six witnesses testified, spokesmen for the Foundation, the Office of Science and Technology, the Bureau of the Budget,

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[1] Emilio Q. Daddario, "A Revised Charter for the Science Foundation," *Science*, CLIII (April 1, 1966), 42.

[2] *Ibid*., p. 44.

and the National Academy of Sciences expressed guarded support of the provision to authorize NSF to support applied research.[1]

Leland J. Haworth, the Director of the Foundation, stated that he welcomed the proposal to authorize NSF to support applied research. However, he cast his support of this proposal in terms of supporting engineering education, rather than in terms of a strong desire on the part of the Foundation to undertake research relevant to the resolution of national problems. He stated that:

> In its support of research, the Foundation has, in my opinion, reached the limit of what can be defined as "basic research," particularly in engineering. Hence, to the extent that engineering schools are dependent upon support from the Foundation for their research activities, the limiting of such support for research to that which is purely basic interferes with the ability of the schools to expand knowledge and to enrich their curriculums.[2]

Haworth also supported the proposal to authorize the Foundation to support applied research on the grounds that the Foundation would be enabled to extend support to investigators to follow promising leads developed in the course of a basic research project. However, he made it

[1] U.S. Congress, House, Committee on Science and Astronautics, A Bill to Amend the National Science Foundation Act of 1950, Hearings before the Subcommittee on Science, Research, and Development, 89th Cong., 2d Sess., 1966.

[2] Ibid., p. 10.

clear that he regarded the proposal as one designed to enable NSF "to be more responsive to the needs of the academic community, not only in engineering, but in other disciplines as well."[1] He objected to the provision in the bill that the applied research be "relevant to national problems involving the public interest" insofar as this provision would apply to the applied research supported by NSF in an academic context. He pointed out that:

> The particular applied research which might be supported to best further . . . education may not, of itself have a direct bearing, at least an obvious direct bearing upon a particular national problem. Likewise, the applied research growing out of basic research which may, in turn, lead to new basic findings, may not have a direct link at the time to a recognized national problem. . . .[2]

In construing the proposal to authorize NSF to support applied research primarily as a proposal to strengthen NSF's support of academic research, Haworth seemed to avoid the question raised by the earlier report of the Daddario Committee: Should NSF have a direct and major role in laying the foundations for the application of science to national problems such as transportation,

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[1] *Ibid.*

[2] *Ibid.*, p. 11.

water pollution, and waste disposal? In a written response to questions submitted to him by the committee after the hearings, Haworth clarified his position by stating that:

> The applied research which I foresee the Foundation supporting . . . would be primarily that which is of interest to the academic community. . . . Such research might or might not be directly and demonstrably relevant to national problems involving the public interest.[1]

Donald F. Hornig, Director of the Office of Science and Technology, took a position similar to that taken by Haworth. He testified that support of applied research by NSF should be concentrated at academic institutions because such research can contribute to education in engineering and other areas. However, he asserted that authority to support applied research should be used "very selectively,"[2] by the Foundation.

William D. Carey, Executive Assistant Director of the Bureau of the Budget, stated that "it is a close question,"[3] whether NSF should be authorized to support applied research. However, he concluded that the Foundation should be authorized to do so for three

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[1] *Ibid.*, p. 25.

[2] *Ibid.*, p. 39.

[3] *Ibid.*, p. 59.

reasons: (1) Such an authorization would remove doubts about the authority of the Foundation to support research in the social sciences and engineering that is often difficult to classify either as basic or applied; (2) Such an authorization would enable NSF to sponsor the "hot pursuit" of practical applications arising out of basic research it was sponsoring; and (3) Such an authorization would strengthen NSF's capacity to support education in engineering. Carey also explicitly recognized the intent of the provision, as described in the committee's earlier reports, by stating that he also thought it would be valuable if NSF were in a position to move ahead with applied research in an area of national interest when fundamental knowledge is too limited to warrant a large-scale effort by a mission-oriented agency.

Frederick Seitz, President of the National Academy of Sciences, stated that he believed he spoke for a "very major segment" of the scientific community in expressing grave reservation about the applied science authorization in the Daddario Bill.

> I am concerned that the support of applied research at academic institutions may be the thin edge of the wedge which could ultimately result in pressures to support mission-oriented work at the expense of basic research.[1]

With considerable reluctance he endorsed the proposal on the grounds that it could contribute to graduate education, particularly in engineering.

The witnesses who testified on the Daddario Bill did not address themselves to the proposal that the Foundation assume a far more vigorous role in laying the foundation for a more vigorous effort to apply science to civilian problems. In his explanation of the bill published in Science on April 1, 1966, Representative Daddario had asserted that the bill would require NSF to:

> Direct, where indicated, some research--basic or otherwise, and including engineering--to help bring the scientific base for new and emerging technologies required in the national interest to the point where their development can proceed through other federal agencies and industry. This will be especially important as we strive to satisfy the major physical problems of urban living--such as transportation, pollution, water supply, housing, and population growth.[2]

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[1] Ibid., p. 98.

[2] Daddario, "A Revised Charter for the Science Foundation," Science, CLIII, 43.

Daddario's remarks indicate that criteria of social need should be used by the Foundation to allocate funds for applied research on substantive problems. In contrast, the witnesses before the committee generally ignored this possibility, and interpreted the applied science provision of the Daddario Bill to constitute an authorization to the Foundation to give more vigorous support to education in engineering and related areas.

A more trenchant interpretation of the applied science provision was made by Dael Wolfle, the publisher of _Science_, in an editorial published in _Science_ on May 13, 1966.[1] Wolfle pointed out that if the applied science and other provisions of the Daddario Bill were adopted, the Foundation:

> . . . will become more clearly a part of the centralized machinery of government directed toward the achievement of national goals. It will not become as mission-oriented as are the Atomic Energy Commission and the Department of Defense. Yet it will move closer to that status. In addition to evaluating projects submitted to it, it will actively select areas of research to be emphasized. Decisions as to what to support and how to use the Foundation's resources will become more centralized, more

[1] Dael Wolfle, "Transforming the National Science Foundation," _Science_, CLIII (May 13, 1966), 869.

> the responsibility of the Director and his staff, and he, in turn, will become more clearly accountable to the Congress and the President for the achievements of the Foundation.[1]

On July 18, 1966, the House passed a version of the Daddario Bill and sent it to the Senate. The bill was not passed by the Senate in the 89th Congress, but will be introduced in both houses in the 90th Congress.

The Daddario Bill exemplifies the fact that the federal government has not yet begun to resolve the problem of applying the nation's scientific and technological resources to many of the nation's social problems. Even if the Daddario Bill is enacted, the Foundation's fundamental orientation towards pure research in an academic context makes it unlikely that the Foundation in the near future will vigorously devote itself to efforts to apply science for social purposes. As Dael Wolfle has pointed out, such an attempt could involve the Foundation in political entanglements that it thus far has managed to avoid, at the price of being an essentially conservative and passive agency.

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[1] *Ibid.*

Enactment of the Daddario Bill, however, probably would affect the Foundation's relationships to universities to some extent. The Director of the Foundation pointed out in the Foundation's Fifteenth Annual Report that the phrase "science and technology," when used in reference to national problems such as transportation,

> . . . means broad, multidisciplinary ranges of expertise rather than the narrower concept of specialization which has so long characterized our image of the constituent entities of the scientific enterprise. . . . The National Science Foundation . . . must try to devise more effective ways of facilitating and encouraging partnerships of effort between engineers, natural scientists, and social scientists--partnerships which will increasingly be required if we are to find, without undue delay, adequate solutions to our urgent social problems.[1]

He stated that:

> New approaches to the fulfillment of our responsibilities along these lines may require an examination of the current structure of the Foundation, and if such an examination reveals the need to create new "systems-oriented" units, we stand ready to bring such units into being as promptly as possible.[2]

A movement by the Foundation towards a "systems orientation" to social problems would require the further

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[1]National Science Foundation, Fifteenth Annual Report for the Fiscal Year Ended June 30, 1965 (Washington: U.S. Government Printing Office, 1966), p. xxxi.

[2]*Ibid.*, p. xxxii.

development of alternatives to the project system for the support of research, since the project system is geared primarily to the support of individualized and highly specialized projects. It remains to be seen whether the Foundation will move towards the broad forms of support required for organized and systematic research on complex social problems.

The idea of applying "systems analysis" to social problems has been suggested in many quarters. The terms "systems approach," "systems analysis," and "systems engineering" have various meanings, depending on the contexts in which they are used. In general:

> The systems approach is neither a new technology . . . nor a methodology reserved for the exclusive use of scientists and engineers. . . . It is a way of looking at questions, of analyzing issues, but not a technology in the sense of an applied science or a methodology dealing with the tools of analysis. From this point of view, it is not even a form of analysis. . . . In another sense, however, it is a methodology, for it deals with the principles of intellectual procedure; i.e., the systems approach as an idea or concept prescribes that a subject under consideration be examined in a particular way--by taking account of all factors that seem relevant, noting the

> uncertainties, and investigating the effects of variations in the relevant factors. In most respects, all of this adds up to very little more than an application of common sense, a trait not solely the possession of any single group in our society.[1]

A systems approach generally differs from common sense in that it is often quantitative, multidisciplinary, and rigorously logical. The term "systems analyses" generally refers to the effort to understand the necessary elements and costs of alternative methods of achieving a given objective, while "systems engineering" generally refer to the process of organizing, scheduling, implementing, and evaluating the elements that must be coordinated to achieve a given objective.[2]

"Systems analysis" is related to and sometimes in a public policy context identified with "program budgeting," which is essentially an attempt to determine the various

[1] Ronald P. Black and Charles W. Foreman, "Transferability of Research and Development Skills in the Aerospace Industry," in National Commission on Technology, Automation, and Economic Progress, _Technology and the American Economy_, Appendix, Vol. V, _Applying Technology to Unmet Needs_ (Washington: U.S. Government Printing Office, 1966), p. 117.

[2] See the discussion of the uses of these terms in U.S. Congress, House, Committee on Government Operations, _Federal Research and Development Programs: The Decision-making Process_, Report, 89th Cong., 2d Sess., 1966, pp. 7-8.

costs and benefits of alternative courses of action.[1] There have been two immediate incentives to apply these approaches to civilian problems. The first incentive has been success in using these approaches in defense and space research and development.[2] The second incentive has been the realization that it may be necessary in the future to convert defense and space-oriented industries from defense to civilian ends.[3]

In early 1965 the State of California awarded contracts to four aerospace corporations to study the applicability of systems analysis and systems engineering to civilian problems.[4] The four contracts, each for six

[1] See David Novick (ed.), Program Budgeting (Cambridge: Harvard University Press, 1965).

[2] See Charles J. Hitch and Robert N. McKean, The Economics of Defense in the Nuclear Age (New York: Atheneum, 1965), and U.S. Congress, House, Committee on Government Operations, Systems Development and Management, Hearings before the Military Operations Subcommittee, 87th Cong., 2d Sess., 1962.

[3] See U.S. Congress, Senate, Committee on Labor and Public Welfare, Convertability of Space and Defense Resources to Civilian Needs: A Search for New Employment Potentials, Hearings before the Subcommittee on Employment and Manpower, 88th Cong., 2d Sess., 1964.

[4] The background and content of the studies are examined in detail in Harold R. Walt, "The Four Aerospace Contracts: A Review of the California Experience," in National Commission on Technology, Automation, and Economic Progress, Technology and the American Economy, Appendix, Vol. V, pp. 43-74. See also, Elinor Langer, "Defense: California Planners Try Novel Approach to Problems of Economic Reconversion," Science, CXLVIII (April 23, 1965), 482.

months and $100,000, were awarded to Lockheed Missiles and Space Company for the study of a state information system, Aerojet General Corporation for waste management, Space-General for criminal justice, and North American Aviation for transportation. While opinions on the success of the California experiment seem to vary,[1] the general impression seems to be that the "systems approach" holds great potential for the resolution of social problems in the future, particularly for the physical problems of urban life such as water control, waste management, environmental pollution, and housing.[2]

On October 18, 1965, Senator Gaylord Nelson of Wisconsin introduced in the Senate, S. 2662, which, according to the preamble of the bill, is designed "to mobilize

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[1] Compare Walt, "The Four Aerospace Contracts: A Review of the California Experience," and Black and Foreman, "Transferability of Research and Development Skills in the Aerospace Industry," both in National Commission on Technology, Automation, and Economic Progress, Technology and the American Economy, Appendix, Vol. V, pp. 47-146.

[2] See the testimony in U.S. Congress, Senate, Committee on Labor and Public Welfare, Scientific Manpower Utilization, 1965-66, Hearings before the Special Subcommittee on the Utilization of Scientific Manpower, 89th Cong., 2d Sess., 1966, and House, Committee on Government Operations, The Federal Research and Development Programs: The Decisionmaking Process, Hearings, 89th Cong., 2d Sess., 1966. See also, Black and Foreman, "Transferability of Research and Development Skills in the Aerospace Industry,"; Carter, From Research to Development to Use; National Security Industrial Association, Motivation and Support of Research and Development to Achieve National Goals (Washington: National Security Industrial Association, 1965).

and utilize the scientific and engineering manpower of the Nation to employ systems analyses and systems engineering to help to fully employ the Nation's manpower resources to solve national problems." The bill refers to problems in the areas of education, unemployment, welfare, crime, juvenile delinquency, air pollution, housing, transportation, and waste disposal as examples of national problems. The bill would authorize the Secretary of Labor to make grants to states, universities, or other organizations for the purpose of promoting the use of systems analysis and systems engineering in resolving social problems. Among other things it requires the Secretary to assure that funds are "equitably distributed among the various major geographic regions of the Nation."

In introducing the bill, Senator Nelson stated that it is an attempt to build creatively on the foundation laid by the California studies. He asserted that the California studies have proved that the concept of using space engineering in social problems is a feasible one, and rhetorically asked:

> Why can not the same specialist who can figure out a way to put a man in space figure out a way to keep him out of jail? Why can not the engineers who can move a rocket to Mars figure out a way to move people through our cities and across the country without the horrors of modern traffic and the concrete desert of our highway system? . . . Why can not we use computers to deal with the down-to-earth special problems of modern America? The answer is we can--if we have the wit to apply our scientific know-how to the analysis and solution of social problems with the same creativity problems.[1]

The hearings on the Nelson Bill consisted primarily of explanations of the California studies by representatives of the parties involved, and explanations of the use of systems analysis by various departments and agencies of the federal government. No action was taken on the Nelson Bill following the hearings in May 1966, but new hearings were scheduled for January 1967.

In a related inquiry undertaken in January 1966, the Reuss Subcommittee examined the question of whether the effort devoted to determining the needs, opportunities, costs, and benefits of research and development for

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[1]Congressional Record, October 18, 1965, reprinted in U.S. Congress, Senate, Committee on Labor and Public Welfare, Scientific Manpower Utilization, 1965-66, Hearings before the Special Subcommittee on the Utilization of Scientific Manpower, 89th Cong., 1st and 2d Sess., 1965, 1966, p. 208.

federal civilian programs is comparable to the effort devoted in the defense, space, and atomic energy programs.[1] This inquiry was cast in part in terms of the implications of the Bureau of the Budget directives on Planning, Programming, and Budgeting Systems on research and development allocations.[2]

In this connection, Elmer Staats, Deputy Director of the Bureau of the Budget, told the committee that the planning, programming, and budgeting system (PPBS) ordered to be instituted by the President in 1965 is "new" in the sense that it is a refinement of present attempts to determine the costs and benefits of alternative courses of action, particularly through quantitative techniques. He asserted that:

> How much the new look in budgeting will do to get us better answers in R and D remains to be seen. . . . It can do a great deal to pose the kinds of questions, in basic research and in other kinds of research and development, that go to the core of policy decisions. . . . We would hope that cost-benefit analysis would shed more light on the relative merits of investing in civilian technology to a larger extent than we do at present.[3]

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[1]U.S. Congress, House, Federal Research and Development Programs: The Decisionmaking Process, Hearings and Report, 89th Cong., 2d Sess., 1966.

[2]U.S. Bureau of the Budget, Planning--Programming--Budgeting, Bulletin 66-3 (Washington: U.S. Bureau of the Budget, 1966).

[3]Ibid., p. 12.

In its report, the Reuss Subcommittee was critical of the methods used to allocate research funds to the satisfaction of social ends. The subcommittee asserted that in urban transportation, housing, and water pollution control, federal research programs are disorganized and not well supported. The committee asserted that the Executive Office makes insufficient cost-benefit comparisons of competing claims for federal research and development funds, and called on the Executive Office to place greater emphasis on civilian needs. Whatever the merits of the Reuss Committees' conclusions, they provide another example of demands for greater federal efforts to apply science to social needs in the future. Underlying these demands is the revolution in the relationships of the federal government to metropolitan areas that has materialized since World War II.[1]

[1]See Robert H. Connery and Richard H. Leach, The Federal Government and Metropolitan Areas (Cambridge: Harvard University Press, 1960); U.S. Congress, House, Committee on Government Operations, Metropolitan America: Challenge to Federalism, A Study submitted to the Intergovernmental Relations Subcommittee, by the Advisory Commission on Intergovernmental Relations, 89th Cong., 2d Sess., 1966; Housing a Nation (Washington: Congressional Quarterly Service, 1965); Graves, American Intergovernmental Relations; U.S. Congress, Senate, Committee on Government Operations, Federal Role in Urban Affairs, Hearings before the Subcommittee on Executive Reorganization, 89th Cong., 2d Sess., 1966; U.S. Congress, Committee on Government Operations, Creative Federalism, Hearings before the Subcommittee on Intergovernmental Relations, 89th Cong., 2d Sess., 1966.

The extent to which the federal government will respond to urban needs through research and development programs remains to be seen. The demands that it do so, however, have important implications for the funding of academic research in the future. Greater emphasis on a systems approach to research, and to the examination of urban needs, would require greater emphasis on broader forms of support than the project system.

In conclusion of this section, four major demands have been made on the federal academic research funding system in the 1960's:

1. The demand for responsibility in the administration of funds;
2. The demand for a wider geographical distribution of funds;
3. The demand for the allocation of funds in part on the basis of educational criteria;
4. The demand for the application of funds in part to research of relevance to national problems.

It is in the context of these demands that the President's Memoranda must be interpreted and its implications assessed.

CHAPTER V

THE IMPLICATION OF THE PRESIDENT'S MEMORANDA FOR FEDERAL FUNDING OF ACADEMIC RESEARCH

The demands analyzed in Chapter IV indicate the persistence of several issues in the funding of academic research by federal agencies in the late 1960's and thereafter: the issue of responsibility in the administration of funds; the issue of equity in the distribution of funds; the issue of reconciling research and education, and the issue of applying science and technology more effectively to social problems. The implications of the Memoranda will be analyzed through an examination of the relevance of the Memoranda to the resolution of each of these issues.

The Issue of Responsibility

The essence of the issue of responsibility in the administration of funds is the question of the terms and conditions under which public funds should be provided to private agents for the achievement of a public purpose.

The question of responsibility has four aspects: (1) the accountability for funds; (2) the responsibility for making decisions on such questions as the purchase of equipment and changes in the direction of research; (3) the responsibility of an institution for the conduct of its investigators; and (4) the responsibility of an institution for the determination of its own objectives and policies. The question of university responsibility concerns problems not only of the relationship of the universities to agencies, but also of university administrators to faculty members.

The question of accountability is essentially a question of who should report to the granting agency on how funds are spent, the form such reports should take, and the frequency with which such reports should be made. As discussed in Chapter IV, the National Institutes of Health in the early 1960's expressed a position, held to an indeterminate extent by other agencies, that the critical aspect of the administration of research grants is the selection of good researchers, and that "all subsequent administrative actions . . . are essentially trivial in relation to this basic selection process."[1] As a result of the criticisms expressed by the House Intergovernmental Relations Subcommittee headed by Representative Fountain of North Carolina, this view has not prevailed. In the case of project grants to individual investigators, the necessity for reporting in some detail on the expenditure of funds, on the time spent on projects, on the major changes in the direction of research, and on related matters, is now generally recognized, although there is resistance on the part of investigators to many of these requirements.[2]

The heart of the problem is whether agency administrators can directly and effectively supervise the activities of large numbers of investigatons located in one or two hundred or more universities. The conclusion of the Administration Panel of the NIH Study Committee

[1] Statement of James A. Shannon, Director, National Institutes of Health, in U.S. Congress, House, Committee on Government Operations, The Administration of Grants by the National Institutes of Health, Hearings before the Intergovernmental Relations Subcommittee, 87th Cong., 2d Sess., 1962, p. 14.

[2] These requirements are discussed in detail in Bureau of the Budget, The Administration of Government-Supported Research at Universities (Washington: Executive Office of the President, 1966). On resistance on the part of investigators to these requirements, see Dael Wolfle, "Academic Responsibility," Science, CLIV, No. 3746 (October 14, 1966), 219.

headed by Dean Woolridge is generally accepted:

> For a few hundred people in Bethesda to keep track of the activities of 50,000 investigators in 1,500 places . . . with no intermediate level of supervision, is clearly an administrative impossibility.[1]

The Woolridge Committee found, however, that many universities do not have the managerial capacity to exercise the type of supervision deemed necessary by agencies:

> More often than not, the research scientist is insufficiently supported by his own "front office." In many cases unreasonable restrictions impede his purchase of equipment he needs to do his job: simple and relatively inexpensive facility rearrangements and modifications are frequently almost impossible; information and assistance on the proportion of proposals are typically absent; accounting reports needed by the principal investigator to monitor his compliance with contractual commitments are frequently late and inadequate. Such weaknesses have an important effect on the morale and productivity of the research scientists. . . .[2]

The Woolridge Committee concluded that incentives to the institutions are necessary to cause them to make organizational and administrative changes deemed necessary by federal administrators. The committee specifically asserted that NIH should help provide such incentives by demanding,

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[1] Biomedical Science and Its Administration (Washington: U.S. Government Printing Office, 1965), p. 99.

[2] Ibid., p. 31.

as a condition of project awards, the establishment by the institution of an acceptable program to achieve the quality and quantity of technical supervision and administrative support judged to be necessary to justify the award of funds to a specific institution. Finally, the committee acknowledged that the project grant has been a major contributing factor to the inability or refusal of some institutions to exercise meaningful supervision over the expenditure of funds.

> The award is made to the investigator's institutions as the legal grantee, and usually provides an allowance for indirect institutional expenses, but otherwise the institution's interests and concerns are largely ignored. The lines of day-to-day administration and reporting, except on certain financial matters, run directly between investigator and NIH scientist . . . it appears that NIH, anxious to protect the investigator from any interference that might impair his freedom and thus his productivity, has tended to treat the institution as a possible source of such frustration. Conversely, it appears that the investigator, a party to the traditional tensions between faculty and local administration, has rather comfortably accepted a role as a protege of NIH and of the national community of investigators in his technical field.[1]

The project system has been based on a premise of distrust of institutions as institutions. Whether this

[1] *Ibid.*, p. 99.

distrust is justified or not, the movement to induce universities to exercise a greater supervisory role may increase rather than decrease the tension between agencies and universities in those programs that are based on the premise that the purpose of the funds provided is to "buy" a definite research product. This is the premise on which the Woolridge Committee's analysis of NIH activities was based:

> In general terms, the public funds that support NIH activities are interested to "buy" for the American people a commensurate degree of relief from suffering and improvement of health.[1]

As long as this basic premise is retained, the prospects are for greater intervention by agencies into the internal affairs of institutions. This was recognized by the Woolridge Committee:

> We are aware that we are here recommending what may appear to be an increase in the amount of "control" exercised by NIH over the universities. . . . But we are dealing with an actual, not an ideal, situation.[2]

While the Woolridge Committee only analyzed the activities of one agency, its findings and recommendations have significant implication for the funding of research

[1] *Ibid.*, p. 2. [2] *Ibid.*, p. 32.

by all agencies, as the use of these findings by the Bureau of the Budget indicates.[1] The Woolridge report raises the prospect of several agencies acting either separately or in concert to influence further university organization and management for research purposes. Before examining the relevance of the President's Memoranda to this prospect, it is necessary to consider the other aspects of responsibility--the responsibility of an institution for the conduct of its investigators and for the determination of its own objectives and policies.

The problem of an institution's responsibility for its own development, analyzed in the context of federal support of research, is essentially a problem of the capacity of an institution to piece together from a great multiplicity of federal programs and other sources of funds a pattern of developing in a consistent way in a direction judged desirable by university trustees, administrators, and faculty. Most universities, of course, have never enjoyed "autonomy," in the sense of freedom from direction in growth from state legislatures, foundations, and private

[1] Bureau of the Budget, The Administration of Government-Supported Research at Universities.

donors. However, the magnitude of federal research funds has been so great that many institutions have, without conscious design, grown in directions made possible by federal research funds, whether growth in these directions was desirable or not. This situation has long been recognized by agency administrators and by others. For example, James Shannon told the Fountain Committee in 1962 that:

> If one takes one segment of . . . individual program actions, and tries to follow the Federal dollar down to the separate transactions . . . without facing up to the consequences of the type of support we are giving in this country today to higher education, one will conclude that the systems are grossly deficient. Any system in the support of science, in a country such as ours, that depends on multiple actions by multiple agencies and requires the institution to put the support of these multiple agencies, with their different aims, together into some sort of stable mechanism, will have serious faults. You cannot patch up the aggregate, however much attention one pays to the individual action. The system is basically at fault.[1]

The same point was repeatedly stressed by the teachers and university administrators where views were solicited by the Reuss Subcommittee,[2] and underlies the institutional

[1]U.S. Congress, House, Committee on Government Operations, The Administration of Grants by the National Institutes of Health, Hearings before the Intergovernmental Relations Subcommittee, 87th Cong., 2d Sess., 1962, p. 58.

[2]U.S. Congress, House, Committee on Government Operations, Conflicts Between the Federal Research Programs and the Nation's Goals for Higher Education, responses from the academic and other interested communities to an inquiry by the Research and Technical Programs Subcommittee, 89th Cong., 1st Sess., 1965.

grants programs discussed in Chapter III.

While there is no single, simple answer to the responsibility question, the one answer that is endorsed in the President's Memoranda and supported by many critics[1] of federal policies is to increase the amounts of funds provided to universities for use by the universities as they think fit, with the qualification that the funds must be spent for the advancement of science, broadly defined. The rationale underlying this idea is that broad grants will serve as an incentive to universities to establish managerial competence in research, and will enable institutions to exercise greater control over research processes conducted under their jurisdictions. Don K. Price has expressed this point in the assertion that the problem of responsibility

> . . . can only be solved by a system which gives the university an incentive to take the same point of view as that required by the higher interests of government policy. And this is of course the most powerful argument for moving, at least in part, from a system which bases support for research on a series of small, narrowly defined projects to a system of broader general grants. . . . It is . . . the precisely

[1] See, e.g., Price, "Federal Money and University Research," Science, CLI, 285.

> restricted funds, controlled by the intentions of the donor, which a university administration has no incentive to control in the interest of academic austerity. For this reason I think that a waste of funds would be greatly reduced if, on the whole, the government--without giving up the project grant as its main instrument of support--would move in the direction of support on a broader basis, putting more general substantive as well as financial responsibility in the hands of the university faculties and administration.[1]

The President's Memoranda do not directly discuss the question of responsibility, other than to enjoin agency efforts to strengthen the capacities of institutions to perform research. Agencies are enjoined to "provide research funds to academic institutions under conditions affording them the opportunity to improve and extend their programs for research and science education. . . ."

In its report[2] issued six months after the President's Memoranda, the Bureau of the Budget elaborated in detail on methods of improving the relationships between agencies and universities. The Bureau recommended abandonment of grants and contracts as research instruments, with the exception of the use of contracts in limited cases. It recommended the use of a research agreement between

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[1] *Ibid*., p. 288.

[2] Bureau of the Budget, *The Administration of Government-Supported Research at Universities*.

agencies and universities to emphasize the role of the university in the administration of grants, and to move away from the notion that the individual researcher is a recipient of a gift under the typical grant. The Bureau also asserted that greater uniformity in agency administrative policies is essential to relieve the burden on universities. Finally, on the question of university responsibility the Bureau asserted that:

> Tighter administrative controls in Federal research programs have imposed a substantial administrative burden upon the universities and have in some areas removed from the universities responsibilities for managing their own affairs and regulating the activities of their faculties. This trend to tighter controls could continue in the absence of recognizable improvements in university administration.[1]

When analyzed in the context of the Woolridge and Bureau of the Budget Reports, the President's Memoranda indicate the likelihood of an increase in friction between agencies and universities over the responsibility question. There are several reasons for this. The first is that there is an inherent duplicity in the movement to increase institutional supervision over the research conducted under its

[1] *Ibid*., p. 38.

jurisdiction. On the one hand, there is a general realization by the agencies that a proliferation of project grants to individuals in universities raises difficult if not insuperable problems for the agencies in exercising any meaningful supervision over the conduct of grantees. Written reports in themselves are worthless unless there is some way of ascertaining that what is reported actually transpired. The critical fact is that the agencies extend a great deal of trust to investigators by virtue of the fact that the investigators are employed by reputable institutions and presumably are responsible people. The agencies' strongest defense against criticism for allocating funds to particular individuals probably is that the individuals hold responsible academic positions. The universities therefore are invaluable to the agencies, both in screening potential investigators and in providing the facilities and associations necessary for the conduct of research. On the other hand, the agencies frequently seem to be unwilling to accept the judgments of individual institutions on how responsibility can best be exercised within particular institutions. There is a general distrust that flows from agency administrators towards university organization and management. While this may be justified in many cases, it is by no means clear why or how agencies are in a better position than universities to determine the practices that are suitable in given universities. Implicit in both the Woolridge and Bureau of the Budget reports is the proposition that universities must become more like business organizations, yet movements in this direction may weaken or destroy the environment of flexibility and freedom that universities are supposed to provide. The point of critical importance is that the project system was devised by the agencies and national groups of scientists, not by the universities. As the deficiencies in this system become apparent it seems inconsistent for federal policy makers to insist that universities change their practices or undergo further intervention by agencies in internal university affairs.

The President's Memoranda may aggravate this situation because they call for broader grants to universities. If broader grants are made on the same basic premises on which project grants are made, the universities will have greater managerial responsibilities, and may come under even more intense pressures from agencies to follow practices that the agencies consider desirable or necessary. In this situation, differences could be further aggravated. However, the balance of power lies with the agencies, since they control the funds. Large, well-endowed, and experienced institutions may be able to withstand further pressures. In the case of institutions that have been heavily engaged in research programs and have established internal procedures deemed adequate by agencies, pressures will not be necessary.

This leads to the second reason why further difficulties may develop over the responsibility question, which is that the President's Memoranda should have their greatest impact on weaker institutions, rather than on stronger ones. One fundamental purpose of the Memoranda is to provide research funds to institutions that have not previously received substantial funds. These are the institutions, however, that may be judged by agencies to need the exercise of internal controls by the agencies. These institutions may not be equipped to handle funds in what agencies deem to be a responsible manner. The result could be pressures for standardization of university and college organizations and procedures.

This leads to the final observation. Although the Memoranda are designed to spread research funds to "have not" institutions, the difference in these funds from funds provided on a strict merit basis should be explicitly recognized and taken into account in fund administration. Developmental research funds provided to institutions in response to the Memoranda should not be subjected to the same type of administrative scrutiny as the funds provided on a merit basis. Although this is not always acknowledged, funds provided to institutions for the purpose of increasing the research capacities of institutions border on aid to these institutions. Aid funds are distinguished from research funds in this context by the test of whether the funds are provided for the value of the potential product that may result from the research, or whether funds are provided for the value of the process of research to the individuals and institutions engaged in it, with only secondary emphasis on the value of the product produced. Aid funds are provided for the presumed value of the activity itself, whatever the immediate product of that activity may be. Research funds presumably are provided because of the potential value of the product expected to result from the process. While responsibility must be exercised in both cases, the nature of the responsibility will vary on such matters as change in the direction of research, purchase of equipment, accounting for time of investigators, reporting on results produced, and similar matters. While mission-oriented agencies such as the Department of Defense, which, as noted below, is inaugurating a program in response to the Memoranda, may be able to administer developmental funds in a manner different from product-oriented funds, there is a danger that the practices considered appropriate in regular research programs will be superimposed on institutions in developmental programs. For these and similar reasons, it may be a mistake to involve mission-oriented agencies in developmental programs at all, since these agencies are not particularly oriented to providing general aid to education. However, since large amounts of funds go to these agencies, their involvement may be a necessity if developmental programs are to attain any meaningful size.

The Issue of Equity in the Distribution of Funds

The issue of equity in the distribution of academic research funds has two aspects, the equity of fund distribution among various states and regions, and the equity of distribution among institutions. It may be possible to achieve state or regional "equity" by allocating large amounts of funds to one or two institutions in a state or region, to the exclusion of other institutions. For purposes of analyzing the implications of the President's Memoranda for the issue of equitable distribution, these two aspects will be considered together, while the aspect of institutional equity will be given further consideration in the following section on the use of educational criteria in fund distribution.

In political terms, the issue of equity invariably raises the question of pork barrel politics, if that term is used to refer to the process of allocating government funds on the basis of political influence and regional, state, and local demands for a share of funds. Many people hold that demands for equity in the distribution of funds are pork barrel demands. The statement of Kingman Brewster, the President of Yale, is typical:

> It seems to me wholly unwise to permit considerations of political geography to control the choices of faculties and students alike. . . . I see no way, have heard of no way, in which a so-called geographical criterion could be intruded into the process of allocation without being either hopelessly wooden and arbitrary on the one hand, or hopelessly corrupting on the other.[1]

On the other hand, it is argued that the label "pork barrel" is simply a verbal smokescreen used by the beneficiaries of the present system to obscure the merits of the arguments of those who favor the use of some

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[1]U.S. Congress, House, Committee on Science and Astronautics, Distribution of Federal Research Funds and Indirect Costs re Federal Grants, Hearings, 88th Cong., 2d Sess., 1964, p. 448.

geographical criteria in the distribution of funds. Many agree with Philip H. Abelson, the editor of Science, that the geographical question is not merely a pork barrel one, but a question with long range implications for the development of the United States.

> The present allocation of funds for research is not in the long-term national interest. One can only be amazed that Congressmen from the underprivileged states have been so remiss in safeguarding the interests of the nation and their constituents.[1]

In this vein, Russell Thackery, Executive Director of the National Association of State Universities and Land-Grant Colleges, told the Federal Inter-Agency Committee on Education on January 26, 1966, that:

> The cry of "pork barrel" or "politics in science" is almost invariably raised by those who sit in the seats of power in the politics of science, and dry out against the possible intrusion of politics into science. . . . The best way to get politics as politics out of science so far as is possible, and keep it out, is to use an objective, easily determinable method of assuring support for the development of science and education in the sciences, in all parts of the country, in all institutions, for the benefit of all students. This is the antithesis of "pork barrel." By satisfying a legitimate and scientifically sound need, it would substantially

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[1] Philip H. Abelson, "Distribution of Research Funds," Science, CXLII (October 25, 1963), 453.

> reduce and in many cases eliminate pressures to satisfy it through political channels, pitting institution against institution, region against region, state against state.[1]

By most definitions of "politics," such as "the authoritative allocation of values," the present system of fund distribution is clearly a political one.[2] However, it is not a political one in the sense that it depends heavily on political parties, or the normal budgetary process of agency and Bureau of the Budget proposals and congressional review. While the levels of appropriations for research are processed in the usual manner, subject to the give and take of competing claims, the distribution of funds to regions and institutions and individuals is not. This process has been left to the agencies, most of which have relied heavily on boards of scientists in distributing funds. The movement is towards greater congressional involvement in the determination of distribution patterns. In this sense, the demand for equity is in part a demand for a closer integration of distribution procedures

[1]Unpublished statement of Russell Thackery, Executive Director of the National Association of State Universities and Land-Grant Colleges, to the Federal Inter-Agency Committee on Education, January 26, 1966.

[2]See Robert A. Dahl, Modern Political Analysis (Englewood Cliffs: Prentice-Hall, 1963).

into the agency and Budget Bureau-congressional review appropriations process.

In policy terms, the equity issue is basically a question of whether academic research funds should be allocated in part on the basis of the economic, educational, and sound needs of states or regions. While no single definition of "region" is suitable for all purposes, the Census classification is often used for purposes of analysis. This classification is indicated in Chart IV.

CHART IV

CLASSIFICATION OF STATES, BY REGION AND GEOGRAPHIC DIVISION

<u>North East</u>

New England

- Maine
- New Hampshire
- Vermont
- Massachusetts
- Rhode Island
- Connecticut

Middle Atlantic

- New York
- New Jersey
- Pennsylvania

<u>North Central</u>

East North Central

- Ohio
- Indiana
- Illinois
- Michigan
- Wisconsin

West South Central

- Minnesota
- Iowa
- Missouri
- North Dakota
- South Dakota
- Nebraska
- Kansas

South	West

South

South Atlantic

- Delaware
- Maryland
- District of Columbia
- Virginia
- West Virginia
- North Carolina
- South Carolina
- Georgia
- Florida

East South Central

- Kentucky
- Tennessee
- Alabama
- Mississippi

West South Central

- Arkansas
- Louisiana
- Oklahoma
- Texas

West

Mountain

- Montana
- Idaho
- Wyoming
- Colorado
- New Mexico
- Arizona
- Utah
- Nevada

Pacific

- Washington
- Oregon
- California
- Alaska
- Hawaii

As was discussed in Chapter II, there are considerable variations in the amounts of funds received by individual states. As indicated in Table 40, there are also considerable variations in the amounts received by geographic divisions. In 1965, of the total federal support of $2,233,400 provided to universities and colleges, the Middle Atlantic states received 18.7 percent, the East North Central states, 18.4 percent, and the Pacific states, 16.2 percent. In contrast, the East South Central states received 4.1 percent, the Mountain states, 4.9 percent, and the West South Central states, 6.6 percent.

TABLE 40

DISTRIBUTION OF FEDERAL SUPPORT TO UNIVERSITIES AND COLLEGES, BY GEOGRAPHIC DIVISION AND TYPE OF SUPPORT, 1965
(in millions of dollars)

Geographic Division	Total Federal Support	Total Academic Science	Other Educational Activities
U.S. Total	$2,273.4	$1,730.1	$543.2
	Percent Distribution		
U.S. Total	100.0	100.0	100.0
New England	9.9	11.2	6.1
Middle Atlantic	18.7	19.9	15.1
East North Central	18.4	18.4	18.5
West North Central	7.5	7.3	8.3
South Atlantic	13.1	12.0	16.5
East South Central	4.1	3.7	5.4
West South Central	6.6	6.1	8.3
Mountain	4.9	5.0	4.7
Pacific	16.2	16.1	16.6
Puerto Rico	.6	.6	.7

Source: National Science Foundation, Federal Support for Academic Science and Other Educational Activities in Universities and Colleges, Fiscal Year 1965, p. 16.

As is indicated in Table 41, federal support for academic science--research and development, research plant, and fellowships and other student support--when measured per graduate student enrolled in the sciences and engineering, ranges from a high of $14,280 per student in the New England states to $8,070 in the West South Central states.

TABLE 41

FEDERAL ACADEMIC SCIENCE SUPPORT PER GRADUATE STUDENT ENROLLED IN SCIENCES AND ENGINEERING, BY GEOGRAPHIC DIVISION AND STATE, 1965

Division	Support Per Graduate Student Enrolled in Sciences and Engineering
New England	$14,280
East South Central	12,040
South Atlantic	11,200
Pacific	10,370
East North Central	9,600
Mountain	9,100
West North Central	8,820
Middle Atlantic	8,760
West South Central	8,070

When federal academic science support is compared with graduate enrollment and Ph.D. degrees awarded, the results are as indicated in Table 42. The East North Central states in 1965 awarded 25.1 percent of the Ph.D. degrees, had 19.1 percent of the graduate school enrollment, and received 18.4 percent of the funds. The Middle Atlantic states, with 18.8 percent of the Ph.D. degrees awarded, and 22.6 percent of graduate student enrollments, received 19.9 percent of the funds. The Pacific states, with 14.5 percent of the Ph.D. degrees awarded, and 15.5 percent of graduate school enrollments, received 16.1 percent of the funds. As was true of the Pacific states, the New England states received a higher percentage of federal funds, 11.2 percent, than the percentage of graduate students enrolled in these states, 7.8 percent, and the percentage of Ph.D. degrees awarded, 10.6 percent. The South Atlantic states also received a higher percentage of funds, 12.0 percent, than the percentage of graduate students enrolled, 10.7 percent, or Ph.D. degrees awarded, 9.5 percent.

TABLE 42

COMPARISON OF FEDERAL ACADEMIC SCIENCE SUPPORT WITH GRADUATE ENROLLMENT AND Ph.D. DEGREES AWARDED, BY GEOGRAPHIC DIVISION, 1965

Geographic Division	Percentage of Total Federal Funds for Academic Science to Universities and Colleges Proper, 1965	Percentage of U.S. Total Ph.D. Degrees Awarded in the Sciences and Engineering, 1963-64	Percentage of U.S. Total Graduate Student Enrollment in the Sciences and Engineering Fall, 1964
New England	11.2	10.6	7.8
Middle Atlantic	19.9	18.8	22.6
East North Central	18.4	25.1	19.1
West North Central	7.3	9.6	8.3
South Atlantic	12.0	9.5	10.7
East South Central	3.7	2.4	3.0
West South Central	6.1	6.1	7.5
Mountain	5.0	3.4	5.4
Pacific	16.1	14.5	15.5

Source: National Science Foundation, _Federal Support for Academic Science and Other Educational Activities in Universities and Colleges, Fiscal Year 1965_, p. 19.

While useful for certain analytical purposes, there is no agreement on any statistical measurement of equity or inequity in the distribution of funds. In qualitative terms, the essence of the equity issue is the question of whether research funds should be distributed to regions, states, and institutions on a basis other than merit.

The President's Memoranda, in reference to the distribution question, assert:

> Our policies and attitudes in regard to science cannot satisfactorily be related to achievement of goals and ends we set for our research. Our vision in this regard is limited at best. We must, I believe, devote ourselves purposefully to developing and diffusing--throughout the nation--a strong and solid scientific capability, especially in our many centers of advanced education. . . . At present, one-half of the Federal expenditures for research go to 20 major institutions, most of which were strong before the advent of Federal research funds. During the period of increasing Federal support since World War II, the number of institutions carrying out research and providing advanced education has grown impressively. Strong centers have developed in areas which were previously not well received. It is a particular purpose of this policy to accelerate this beneficial trend since the funds are still concentrated in too few institutions in too few areas of the country.

As noted above in the discussion of the issue of responsibility, the focus of the Memoranda is on the development of institutions. The result of this focus on institutions is the introduction of criteria other than criteria of scientific merit in the distribution of funds. The critical question, however, is whether the present system should be retained and supplemented by gradual, incremental additions oriented to a wider distribution of funds, or whether the existing system should be substantially modified to bring about some immediate redistribution through existing programs.

The strategy of the Johnson Administration on this question was expressed by Donald Hornig in his capacity as Director of the Office of Science and Technology, on July 25, 1966, to the Senate Committee on Government Operations, Subcommittee on Government Research, chairmaned by Senator Fred Harris of Oklahoma, in the course of hearings on the Memoranda and related matters.[1] The strategy is to preserve the existing system, supplement it with programs designed to enhance the research capacities of

[1]At the time of this writing these hearings on the President's Memoranda and related matters have not yet been printed. The quotations in this section are from copies of the statements submitted to the subcommittee by the witnesses.

selected institutions, and rely heavily on local initiative and other types of programs than academic research programs to relieve the pressures for wider institutional and geographic distribution of research funds. Hornig stated there is a need for a wider institutional and geographical distribution of federal funds, but said:

> Changing the distribution of research funds is not the best mechanism. New programs aimed at development are called for . . . it does not seem to me that a redistribution of existing monies will solve the issue.[1]

In general, Hornig defended the existing system, arguing that measured by such factors as Nobel prizes awarded to American scientists, and the mission successes of various agencies, the research funding system has been soundly organized and soundly administered. He stated it is true that some geographical areas have received more funds than others, but asserted:

> The statement has been made that the administration of research programs has been biased to unduly favor certain areas. I do not believe there has been a geographical bias; there has, of course, been a decided bias in favor of excellence wherever it existed. For programs in which scientific leadership was the prime

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[1]Statement by Donald F. Hornig, Director, Office of Science and Technology, before the Senate Committee on Government Operations, Subcommittee on Government Research, July 25, 1966, pp. 14-15.

> goal, the grant decisions were based primarily on the merit of the scientific program and the merit of the scientists involved in the program, no matter where in the country they are.[1]

The unevenness in the distribution of federal support throughout the country is real, but it arises from the uneven distribution of strong universities with strong graduate departments.

> The "less favored" regions are in fact the regions which have not built up academic institutions which can submit their share of meritorious applications. Consequently, the real problem is to expand and improve higher education in these regions.[2]

The position taken by Hornig was that the basic objective of the federal academic research funding system should be the support of high quality research in the United States. This objective cannot be realized by changing the present system, but by increasing the capacities of weak institutions to fully participate in the system. The problem is not in the nature of the system, but in the lack of capacity in many institutions to successfully compete within the system, that is, the inability of investigators in weak institutions to submit good

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[1] *Ibid*., p. 8.

[2] *Ibid*., p. 9.

proposals and to get their proposals accepted by their peers.

In addition to the support of quality research, Hornig asserted, the federal academic research funding system should to some extent be oriented to the realization of two other objectives, the objective of making high quality education accessible to all young people, and the objective of developing strong intellectual centers in every region of the country. In the pursuit of these objectives there is a need for new attitudes and new programs. Direct federal support of institutional development may be one means of attempting to realize these objectives. However,

> Federal help may be sought but, even in the cases where it is given, it is unlikely to be very effective unless supported by substantial local resources. Research funds, in themselves, are inadequate to do the job. . . . While there is expectation of further federal support if the institution meets the appropriate standards, it is nevertheless true that the higher quality staff and facilities cannot be maintained unless there is substantial non-federal support as well.

Furthermore, the federal government should not decide to help the development of a weaker institution unless the government is assured that the potential for growth is solid. There are three basic criteria by which the potential for growth can be evaluated. First, there must be a sound state plan for the concentration of resources in graduate institutions of critical size, as in California, Texas, New York, and Ohio. "Other states have let universities proliferate to the extent that no institution can have enough graduate students to run a complete, viable program." These states will have to change before institutions within them will merit federal support. Second, the state must be willing to pay the price of excellence. Salaries must be competitive, and institutions must encourage faculty members to spend time on research. States with low taxes and low expenditures for higher education are not in a position to warrant federal support. Finally, those states in which only a small fraction of the high school graduates go to college cannot expect to produce the potential for excellence that warrants federal support.

In the conclusion of his statement, Hornig asserted that:

> The presence of a developing scientific center in a community can be an important source of technological strength for the region, and on a broader level seems to provide an important psychological focus for the determination to improve the area.[1]

However, a redistribution of existing monies will not help to solve the problem of establishing such centers throughout major regions of the country. Furthermore, this objective cannot be entirely achieved through the funding of research. It seems likely that it will be necessary to devise combinations of new programs and to increase financial assistance in the near future to accelerate the rate of progress towards establishing major centers of research and education in the major regions of the country.

In Hornig's interpretation, the President's Memoranda are basically an extension of the "center of excellence" concept first advanced by the President's Science Advisory Committee in 1960 in the report, _Scientific Progress, the Universities, and the Federal Government_. The critical element in the concept is "excellence." "Excellence" in

[1] _Ibid_., p. 15.

this context means outstanding strength and capability in research, primarily as judged by scientists. The concept as it has been developed is essentially an extension of the premise of the project system from the evaluation of the merits of individual researchers and their work to the evaluation of institutions. However, the emphasis is on the evaluation of potential for excellence, rather than on evaluation of demonstrated excellence. As interpreted by Hornig, the concept is a highly selective one.

The original PSAC report asserted:

> We must hope that where there were only a handful of generally first-rate academic centers of excellence a generation ago and may be as many as fifteen or twenty today, there will be thirty or forty in another fifteen years.[1]

While Hornig's statement did not limit the potential scope of the Memoranda to thirty or forty institutions, it did stress that the scope of the Memoranda does not extend to all institutions that may want to receive research funds. Since the Memoranda orginated in Hornig's office, his interpretation is particularly important. Hornig's interpretation of the Memoranda before the Harris Committee was

[1] President's Science Advisory Committee, Scientific Progress, the Universities, and the Federal Government (Washington: The White House, 1960), p. 14.

made about nine months after the release of the Memoranda, and may have been affected by the cautious response to the Memoranda in the scientific community.[1]

Hornig's statement, with its strong emphasis on local initiative, was caustically criticized by Senator Harris, the subcommittee chairman:

> It seems to me that you and Dr. Haworth . . . have been a little bit patronizing and condescending in treatment of this committee by coming here and saying things which are rather obvious, that educational excellence is primarily a local matter. We all know that. . . . You have spent half your time saying these things are not as bad as you think and are not really as important as you think, but you are doing a whole lot about it. Now, I think if we would recognize this is of great concern, and one which ties in very greatly with the economic development of this country, and with national policy, and quit talking down to members of Congress as you have done . . . then we would come a lot nearer to getting down to some case here.[2]

As might have been expected, representatives of the major agencies generally argued that they have done as much to achieve a broad distribution of their funds as possible within the limitations imposed upon them by their missions. James Shannon, the Director of NIH, said:

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[1]See Abelson, "New Centers of Excellence," Science, CL, 11.

[2]Quoted in Daniel S. Greenberg, "National Research Policy: Ambuscade for the 'Establishment,'" Science, CLIII, No. 3736 (August 5, 1966), 611.

> I do not come before this Committee clothed in sack cloth and ashes to confess shortcomings on the part of NIH and its programs and with a commitment to do better in the future and to propose a whole new series of programs which will accomplish objectives which we agree with the Committee are highly desirable.[1]

He argued, as did representatives of a few other agencies, that his agency's policies have always been more or less consistent with the objectives expressed in the Memoranda, the strengthening of institutions and a wider distribution of funds. He pointed out that NIH has long provided fellowship support, research facilities support, and support for faculty expansion, and asserted that:

> In this respect, these programs have led the way for all Federal agencies in advancing the objectives of the President's directive of September 13, 1965.[2]

He concluded his statement with the assertion:

> I do not believe that anything of merit will be achieved by simple "sharing of the wealth of science support" on any kind of formula basis. I do not believe any program or plan of support is reasonable as a Federal action in the science field unless it requires as a counterpart a deep local commitment to excellence. To emphasize this point, I would say that a program that contains no science is better than a program characterized by poor science.[3]

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[1]Statement of James A. Shannon, Director, NIH, p. 4.

[2]*Ibid*., p. 9.

[3]*Ibid*., p. 13.

Donald M. Macarthur, Deputy Director for Research and Technology, the Department of Defense, directed most of his testimony to an explanation of a new program designed by DOD as a direct response to the Memoranda, Project Themis.[1] This program, for which $20 million was appropriated for fiscal year 1967, is specifically designed to provide a wider geographical distribution of defense research funds, and to favor institutions not heavily supported by any federal agency. The Department intends to allocate a minimum of $200,000 to 50 institutions the first year. This program will be similar to NASA's Sustaining University Program in that the emphasis will be on the support of research of general relevance to the Department's mission, with the control of funds vested in part in university administrative personnel. The new program is predicated on the belief that:

> Existing centers of excellence continue to act as powerful magnets in well-supported institutions, leading to an unequal distribution of research talent among the institutions as a whole. Only development of additional and equally attractive centers, well equipped for graduate research at an advanced level can, in the end, provide a general equalizing influence. It will be

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[1] For a discussion of this program, see Luther J. Carter, "Project Themis: More Research Dollars for the Have-Nots," <u>Science</u>, CLVI, No. 3762 (February 3, 1967), 548.

> our objective to help in support of the development of such centers in those institutions which have not had the capability to provide necessary development funds either from their own resources or from previous governmental development programs.[1]

In his statement to the committee, Leland J. Haworth, the Director of the National Science Foundation, summarized current and projected programs of the various agencies oriented to effect a wider geographical and institutional distribution of funds. These programs are:

1. The Sustaining University Program of the National Aeronautics and Space Administration, which is designed to support institutions, as institutions, in the conduct of research and the education of students in fields relevant to NASA's mission;

2. The General Research Support Program of the National Institutes of Health, which provides flexible assistance to health professional schools heavily engaged in health related research;

3. The Biomedical Science Support Program of NIH, inaugurated in 1965 to extend flexible support to non-health professional colleges and universities;

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[1] Statement of Donald M. Macarthur, Deputy Director, Research and Technology, Department of Defense, p. 11.

4. The Health Sciences Advancement Awards of NIH, inaugurated in 1966 to provide support to institutions, primarily at the graduate level, to strengthen capabilities in health research and related graduate education;

5. A variety of programs of the Office of Education authorized by the National Defense Education Act of 1958, the Higher Education Facilities Act of 1963, and the Higher Education Act of 1965;

6. The Institutional Grants for Science Program of NSF, based on a formula which provides "free" funds as a percentage of the project funds received by an institution;

7. The Science Development Program of NSF, the object of which is the broad and rapid development of a limited number of institutions with a demonstrated potential for the achievement of excellence, on a regional basis;

8. The Departmental Development Program, initiated by NSF in 1967, to support a single science department or interdisciplinary area in institutions which

are not ready to achieve over-all excellence, but may be able to attain excellence in one or more departments;

9. The College Science Improvement Program, planned by NSF to improve the total science enterprise of selected undergraduate institutions;

10. The new program planned by the Department of Defense to bring together defense mission requirements for research and the center-of-excellence concept.

Like Hornig, Haworth argued that the basic objective of most of these programs is, and should be, to widen the eligibility of researchers and institutions for research funds under the project system. Like Hornig, he emphasized the importance of the attainment of "excellence" in terms of national standards. Like Hornig, he emphasized that excellence as thus defined cannot be achieved solely through federal money. "There must be local initiative, and planning and encouragement and financial support, too. And there must be a local drive for attainment of high quality."[1] Haworth asserted that perhaps the most important need is

[1]Statement of Leland J. Haworth, Director, National Science Foundation, July 25, 1966, p. 22.

for planning on a state and regional basis.

> To be most effective, development on a state and regional basis must, in my opinion, involve local planning on a scale broader than that of individual institutions. . . . Planning of this sort should be on a multi-state or regional basis with careful attention to the specific needs of the region in terms of its geography, its resources, its present and potential industries, and so forth. By so doing, it should be possible to minimize the effect of too wide dispersion of talents and resources and to concentrate effort in such a way that the "critical size" essential to high quality and effective results can be achieved.[1]

Haworth concluded with an assertion that associations of colleges and universities in the various geographic regions should be asked to evaluate the capabilities of their institutions and to recommend ways in which the federal agencies, state and local governments and the private sector can help to strengthen and develop local centers of excellence. The logical course might be to seek agreements through which institutions on a regional basis would specialize in particular disciplines. However,

> The goal of raising less favored institutions in every region of the country to higher standards of excellence cannot be

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[1] *Ibid.*, pp. 23-24.

> achieved on the scale we would like at the present level of expenditures. What we need is time to allow our present and planned programs to take effect and an objective evaluation of our regional requirements and the funds needed to meet them.[1]

Representatives from several small universities and colleges in "less developed" regions were asked by the Harris Committee to give their views on the President's Memoranda. With a dramatist's sense, the committee attempted to contrast the views of those in the "scientific establishment" with those outside of "the establishment."

H. W. Linn, S.J., President of the Creighton University, Omaha, Nebraska, in his analysis of the Memoranda asserted that:

> A shift in language and intent must occur if the smaller institutions, some faced with less than optimal geographic locations for attracting research personnel and their families, are to contribute according to their potential and desires. Smaller institutions must be provided with research funds <u>without</u> the necessity for indicating ability comparable to larger ones. . . . What could accomplish a very significant improvement in research ability would be the support of programs appropriate to the size and nature of the smaller institutions without the necessity that these smaller schools attempt to become miniature versions of the larger research institutions.[2]

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[1] <u>Ibid</u>., p. 26.

[2] Statement of H. W. Linn, S.J., President, The Creighton University, Omaha, Nebraska, July 26, 1966, p. 2.

The representatives of the "have-not" institutions were also asked by the Harris Subcommittee whether the President's Memoranda, as of July 1966, had had any discernible impact on the amounts of federal funds received by their institutions. Most of them testified that the Memoranda had not had any immediate effect up to that time, although several witnesses expressed a belief that the major agencies were beginning to display greater receptivity to proposals from their institutions. Many of the representatives of "have-not" institutions echoed the sentiment expressed by H. W. Linn, S.J., that the Memoranda tend to perpetrate a pattern of funding that may not be suitable for small colleges, or for all universities. For example, Herbert R. Albrecht, President of North Dakota State University stated that:

> We have shaped much of our support from the Federal Government to the institutions of higher education into a pattern that tends to reduce diversity and to enforce a single uniform pattern upon all the institutions. To compete successfully for federal grants, we must all try to become more like Harvard, if I can use that institution as a symbol, when it seems likely that we could better

> serve the interests of our communities, states, and nation by seeking excellence in terms of our own competence and the needs of our own constituents.[1]

He argued that the present system, which would be continued under the interpretation of the President's Memoranda propounded by Hornig, is predicated on a uniform, national standard of excellence as defined by national boards of scientists, and agencies in pursuit of their missions.

> We need to recognize that there are many different kinds of excellence. Not all universities can--or should--try to maintain extensive programs in high-energy nuclear physics; but I would like to think that, at least in proportion to the costs involved, a solid undergraduate program in physics at North Dakota State is as much in the national interest in the long run as the work that will be carried out in the proposed 200-Bev accelerator whose location is now causing so much concern.[2]

He argued that increased federal research dollars would help his university to attract faculty and researchers, but "increased funding alone won't help enough--the _system_ of funding needs also to be altered if we are to succeed in building a solid foundation for our program." In the present system individual scientists and whole institutions must bid

[1]Statement by Herbert R. Albrecht, President, North Dakota State University, July 27, 1966, p. 3.

[2]_Ibid._, p. 2.

for support in the form of project proposals and institutional development proposals. They must continually seek to sell themselves and to know who the potential agency buyers are at the moment, the types of successful bidders that seem to be in favor, and the best forms of salesmanship. The whole system is inappropriate to the basic need of an institution designed to service the region in which it is located on a stable basis, the need for a modest but continuing level of support through funds available for use by the institution to develop itself according to its understanding of its own capabilities and the needs of the region it serves.

Although the President's Memoranda are designed at least in part to "spread the wealth" of research funds, the Harris hearings indicate that the policy set forth in the Memoranda will increase rather than decrease demands for fundamental changes in the existing research funding system. The reasons for this are as follows.

As long as research and related funds are allocated through a system based, at least in theory, on the capability of investigators to perform research as measured by the judgment of their peers, there is a politically defensible rationalization for the resulting distribution pattern. The project grant-peer judgment review system is rooted in a powerful ideology of science as a self-regulating social system.[1] This ideology or belief system has two elements: the idea that science as a social and political system must be regulated by scientists if it is to function effectively, and the idea that science must be supported on its own terms because of the value of its potential results to society. The basic ideology is apolitical in character.[2] Other groups in American life, of course, have also used an apolitical or anti-political ideology to achieve what they have wanted. In this case scientists have wanted federal funds, but they have not wanted to be held accountable for the distribution of funds except in terms acceptable to themselves.

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[1]See Michael Polanyi, "The Republic of Science," a lecture delivered at Roosevelt University, January 11, 1962, for a statement of the pure theory of science as a self-regulating process.

[2]See Robert C. Wood, "Scientists and Politics: The Rise of an Apolitical Elite," Scientists and National Policy Making, ed. Robert Gilpen and Christopher Wright (New York: Columbia University Press, 1964).

Nonetheless, the premises of the system are not universally accepted.[1] Daniel S. Greenberg asserted in June 1966, that:

> One strand of political feeling that now seems to be developing toward federal support of basic research is reminiscent of what John Wanamaker is reputed to have said of his advertising budget--namely, he knows that 50 percent is wasted, but he doesn't know which 50 percent.[2]

As the system has been subjected to scrutiny, there has been a tendency for some conflict among scientists to develop, particularly along disciplinary lines, over who should get what share of the total funds.[3] Despite such strains, the basic premises of the system have stood up under demands that funds be distributed on a basis other than merit as judged by scientists. In other terms the merit principle, however sound or unsound it may be in practice, has served as a shield from demands based on other principles. The merit principle may well be a sound one when the question is one of support of individual researchers.

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[1]See Greenberg, "Basic Research: The Political Tides Are Shifting," <u>Science</u>, CLII, 1724.

[2]Greenberg, "Money for Science: The Community is Beginning to Hurt," <u>Science</u>, CLII, 1486.

[3]See, e.g., National Academy of Sciences, National Research Council, <u>Chemistry</u>: <u>Opportunities and Needs</u>, Report on Basic Research in U.S. Chemistry by the Committee for the Survey of Chemistry; the major argument of which is that research in chemistry has not been adequately funded in relation to other disciplines.

However, when funds are distributed to institutions as institutions on the basis of the potential of institutions to develop high competency in research, the foundation of the rationale in defense of the distribution is removed. The evaluation of the potential of entire institutions to achieve research excellence is not rooted in a powerful ideology, as is the evaluation by fellow scientists of the capacity of an investigator to conduct excellent research, on the basis of the merit of his record and of his proposal. On the contrary, the idea of federal evaluation and judgment of entire institutions is at variance with the tradition of the independence of universities and colleges from federal "domination" and "control." In undertaking to evaluate the potential of institutions to advance themselves, an agency involves itself in judging institutions and certifying institutions for eligibility as major recipients of federal research funds. The shield of dispassionate judgment in the name of scientific merit as indicated by proven ability is removed, since the judgment is of entire institutions, and of potential rather than of actual ability.

The magnitude of agency involvement in the judgment of institutions is exemplified in the selection process used in the National Science Foundation's Science Development Program.[1]

An institution initiates the process through negotiations with a representative of NSF's Division of Institutional Programs. The institution is expected to submit a thorough evaluation of its administrative structure and its present strengths and weaknesses, and a detailed plan for its development, with emphasis on the next five years. The institution is encouraged to retain outside advice in making its evaluation and its plan. These documents are expected to be very detailed and specific on such matters as the institution's sources of funds, its fund raising efforts, its relationships to alumni and foundations, its relationships to the state legislature, if a public institution, its exact plans for growth in specific directions, and further matters. After these documents are examined by the Division of

[1]In late 1966 this program was divided into two programs, the University Development Program and the College Development Program. This summary of the selection process used in the Science Development Program is based on a May 12, 1966, interview with Howard Boroughs, then a member of NSF's Science Development Evaluation Group.

Institutional Programs site visits are made to the institution by NSF personnel. The purpose of these visits is to determine who really runs the institution, whether the administration is strong or weak, whether the institution really has an effective planning group engaged in genuine internal self-improvement or is merely responding to an opportunity for "free" funds, how the faculty feels about the administration, how strong individual departments are, how individual faculty members are treated, whether faculty members are meaningfully consulted by the administration, and similar matters. The proposal is then evaluated by the departments of NSF concerned with substantive areas of science. The proposal is then sent to various people in the country for evaluation, such as university presidents, heads of departmental units in federal agencies, distinguished scientists and professors, business managers, and others. In addition, a visiting team of the advisory evaluation group visits the institution.

The reports submitted by these various people become one document, along with a background study of the institution. This document is then examined within the Division of Institutional Programs, as well as by members of other divisions of the Foundation. The document is then submitted to the Science Development Program Advisory Board, composed of administrators from non-competing institutions, businessmen, and others. This panel then makes a recommendation to the Director of NSF that a grant be made or refused, that further talks be held with the institution, or whatever the case may be. The Director then submits the entire matter to a committee of the Foundation's ruling board, the National Science Board, which exercises final judgment.

This process is not only time-consuming and expensive, but also raises questions about the extent to which it can or should be applied to more than at most a few hundred institutions. The idea of supporting the development of selected institutions through this type of process is based on a premise of uniformity that probably is inapplicable to the large majority of institutions. In order to qualify for development funds, an institution must exemplify a desire and capacity to meet criteria of "potential for excellence" as defined by national standards. As the Harris hearings indicate, some institutions--perhaps the great majority--have neither the capacity nor desire to meet nationally competitive standards, even when cast in terms of "potential."

The President's Memoranda, as interpreted by Hornig and others, do not exemplify an intention to support "have-not" institutions in a manner that may be appropriate to the needs and desires of these institutions.

Finally, supporting institutions on the basis of potential approximates outright aid to these institutions. There is a certain duplicity in supporting institutions under the rubric of "science development" while not supporting institutions as part of a policy to strengthen higher education as a whole. The President's Memoranda are fundamentally defective on the equity issue because the policy endorsed in them was not developed in the context of a more general policy for higher education as a whole. It is true that Office of Education programs are important in funding a variety of activities of colleges and universities. However, as was indicated in Chapter II, Office of Education funds still comprise a small percentage of total federal funds allocated to universities and colleges. The inauguration of a government-wide policy of funding selected institutions as potential "centers of excellence" without the creation of a corresponding policy of providing support to institutions that do not or cannot aspire to this position is going to increase rather than decrease pressures for further modification in the existing system. As discussed below, the ultimate answer should be the creation of a system based on entirely different premises than the premises of the project and center of excellence system. Furthermore, there are good reasons for believing that the insistent intrusion of federal agencies into the internal affairs of institutions through such programs as the Science Development Program, no matter how well intentioned, will ultimately generate intense resentment within universities and colleges that may sabotage the best efforts of agencies to cooperate with institutions in their own developments.

<u>The Issue of the Use of Educational Criteria in the Administration of Funds</u>

As noted in Chapter IV, demands for the use of educational criteria usually take three forms: (1) demands for funds for institutions not heavily engaged in federal research and science education programs, especially for liberal arts colleges; (2) demands for flexible funds to enable institutions to control their own developments, and to promote research in subject areas of interest to the institutions; and (3) demands for funds to enable institutions to "restore the balance" between teaching and research. On paper, the Memoranda directly meet the second demand in the assertion that "support will be provided under terms which give the university and the investigator wider scope for inquiry, as contrasted with highly specific, narrowly defined projects."

As noted in the above discussion--the question of responsibility--there is a definite trend to make grants to institutions under which some decision-making authority over the specific research conducted will be exercised at the institutional level. However, it is unlikely that this type of grant will be extended to institutions with little experience in the conduct of research unless the institution can show a definite potential for excellence.

The President's Memoranda do not confront the question of providing funds to small universities and liberal arts colleges in which the emphasis is on teaching rather than on research, nor do they confront the question of providing institutions with funds to "restore the balance" between teaching and research by enabling institutions to pay higher salaries for teaching, or otherwise work out ways of making teaching attractive to first-rate scientists and scholars. As interpreted by Hornig, and others, the Memoranda are not intended to result in a wholesale shift away from the merit principle either in the project system or in the supplementary institutional development system. The Memoranda do not move in the direction suggested by the Reuss Committee:

> Improvements of science education should be a major goal of all project award programs and, accordingly, effects of a project favorable to science education should often be of decisive importance.[1]

In this assertion the Reuss Committee hit what probably is the most critically important weak spot in the entire research funding system, the failure to support liberal arts colleges and small universities, despite the important role they play in the entire higher education system.[2] The National Science Foundation in 1966 announced that it is creating a College Development Program to assist liberal arts colleges, but this program, like the University Development Program, will be a selective one.

The issue of the inclusion of educational criteria in fund distribution raises the question of whether the project system should be explicitly adjusted to function as an aid to the education system, or whether outright aid should be provided through a different system. On this question the implications of the President's Memoranda

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[1] U.S. Congress, Committee on Government Operations, Conflicts Between the Nation's Research Programs . . . , p. 48.

[2] See U.S. Congress, House, Committee on Science and Astronautics, Higher Education in the Sciences in the United States, Report of the Subcommittee on Science, Research, and Development, 89th Cong., 1st Sess., 1965. See also, Fred M. Hechinger, "Science in the Small College," New York Times, January 8, 1967, p. E11, cols. 1-4.

are clear: the project system should not be turned into an outright aid to the education system. This leaves three alternatives. One, the federal government should not do anything beyond what it is doing through Office of Education programs to support "have-not" universities and colleges. Two, the government should devise a research and science education system based on entirely different premises than the existing system. Three, the government should provide outright aid to colleges and universities for operating expenses on some basis such as the number of students in an institution. For reasons explained in the concluding section below, the position taken in this study is that a research and science education system should be developed on principles entirely different from the principles on which the present system is based. Before explaining the reasons for this position, however, it is necessary to consider the issue of applying research to social needs.

The Issue of Directing and Applying Research to Social Needs

The issue of directing and applying research to social needs arises out of a relatively new social phenomenon, the systematic development of scientific knowledge for the purpose of attaining a predetermined social objective. The *idea* of developing science--that is, knowledge of fundamental principles of nature--for the potential relevance of the understanding acquired, goes back at least to Francis Bacon.[1]

Throughout most of modern history there has been some interaction between the development of science and the desire to achieve various social ends.[2] However, for all practical purposes, the organized and systematic support of science as a means to predetermined social ends on a grand scale dates from the late 1930's. In the words

[1] See Toulmin, "The Complexity of Scientific Choice II: Culture, Overheads or Tertiary Industry," *Minerva*, IV, 155, for a discussion of the historical origins of this idea. See also, Rene Dubos, *The Dreams of Reason* (New York: Columbia University Press, 1961), and Rene Dubos, *The Cultural Roots and the Social Fruits of Science* (Eugene, Ore.: University of Oregon Press, 1963).

[2] See Hendrik W. Bode, "Reflections on the Relation Between Science and Technology," in National Academy of Sciences, *Basic Research and National Goals* (Washington: National Academy of Science, 1965), pp. 41-76, and Aaron W. Warner, Dean Morse, and Alfred S. Eichner (eds.), *The Impact of Science on Technology* (New York: Columbia University Press, 1965).

of the American Association for the Advancement of Science, Committee on Science in the Promotion of Human Welfare:

> In the last 20-30 years an important change has taken place in the relationship between basic science and its technological application to social needs. . . . Now, the origin of technology in basic science is clearly understood and consciously exploited. Major socially useful applications are no longer based on the fortuitous appearance of the relevant scientific knowledge. Instead, a social decision to accomplish a particular technological aim is often made in advance of the necessary scientific knowledge, and the latter is sought for with the express purpose of achieving the desired technology and satisfying a stated social need. . . . This new relationship has, of course, greatly reduced the delays which previously intervened between discovery and application. However, the new relationship has also had a less fortunate effect--it has resulted in technological application before the related basic scientific knowledge was sufficiently developed to provide an adequate understanding of the effects of the new technology on nature.[1]

For purposes of this study, the issue of applying science to social needs raises two policy questions: (1) the question of allocating funds to fields and subject areas with potential relevance to social problems for

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[1] _The Integrity of Science_, Report by the AAAS Committee on Science in the Promotion of Human Welfare, June 1965, pp. 18-19.

basic work in these fields to establish a firm foundation for subsequent applications; and (2) the question of developing methods of using knowledge that already is available and of applying it to social problems. Each of these aspects will be considered in turn.

The question of supporting disciplines and subject areas of potential relevance to social problems in turn raises two further questions, the question of support of social science research, and the question of the support of physical and biological science research with potential direct social value, such as research relevant to environmental control. A major rationale underlying the movement to support social science research can be illustrated by reference to problems created by the use of technology, such as air pollution. While the problem of air conservation has important scientific and technological dimensions, it is apparent that this problem also has social, economic, political, and legal aspects of critical importance. In one sense, the problem is a scientific and technological one. In another sense, it is a social and political one.

The problem exemplifies a fusion of scientific, technological, social, and political elements. It is what Lynton K. Caldwell of Indiana has called a "biopolitical" problem, in that it raises fundamental questions of reconciling scientific, technological, and political processes and values.[1]

The rationale underlying the movement for greater support of social science research is that such problems should be studied as social problems, as well as scientific ones. The Air Conservation Commission of the American Association for the Advancement of Science, Committee on Science in the Promotion of Human Welfare, heavily stressed this point in its four-year study of air conservation.[2]

Among other things, this study exemplifies the critical importance of social, economic, political, and legal research as a foundation for regulatory and other forms of action. The committee asserted that:

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[1] Lynton K. Caldwell, "Biopolitics: Science, Ethics, and Public Policy," Yale Review, LIV, No. 1 (October, 1964), 157.

[2] American Association for the Advancement of Science, Air Conservation, Report of the Air Conservation Commission of the American Association for the Advancement of Science (Washington: The Association, 1965).

> A thorough study of the physical, economic, and social community and alternative future development patterns is as important for air conservation programs as the scientific analysis of the causes, character, and effects of air pollution. Only as the behavior of the people of the region is analyzed can judgments be made on which commitments can be altered.[1]

Others have vigorously argued that in the past, public policy both of a regulatory and a positive nature, in both technologically oriented programs and in other programs, has been based on inadequate knowledge of the behavior patterns of people and of the effects brought about by given programs.[2]

In addition to this public policy rationale, various other arguments have been advanced for increased support of social science research such as the argument that it is dangerous to have scientific and technological knowledge far outstrip knowledge of social processes.[3] While increased federal support of social science research

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[1] Ibid., p. 324.

[2] For a strong statement of this point with several examples, see Barry Commoner, Science and Survival (New York: The Viking Press, 1966).

[3] Some of these arguments are set forth in the President's Science Advisory Committee, Strengthening the Behavioral Sciences, a statement by the Behavioral Sciences Subpanel of the Life Sciences Panel (Washington: The White House, 1962).

may raise many difficult problems, such as the problem of privacy,[1] the prospects are for substantially increased federal support.[2]

The second major aspect of the issue of directing and applying research to social needs is the question of using knowledge that already is available and of applying it to social problems. Proposals for more systematic support of programs designed to put existing scientific and technological knowledge to use in industry and by government rest on the proposition that much effort has been directed to the creation of new knowledge _per se_ but inadequate effort has been made to put this knowledge to work.[3]

The technology transfer program of NASA, the industrial extension service in the process of development by the Department of Commerce under the State Technical Services Act of 1965, the regional program to apply the results of medical research to patient care of the

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[1]See Office of Science and Technology, _Privacy and Behavioral Research_ (Washington: Executive Office of the President, 1967).

[2]See Luther J. Carter, "Social Sciences: Where Do They Fit in the Politics of Science," _Science_, CLIV, No. 3748 (October 28, 1966), 488.

[3]For a discussion of this point, see Nelson, Peck and Kalachek, _Technology, Economic Growth, and Public Policy_.

Public Health Service, and the Office of Education public service programs under the Higher Education Act of 1965, are all examples of efforts to close the gap between the development of knowledge and its applications. As discussed in Chapter IV, the movement to apply systems analysis to social problems is closely related to these programs, since the underlying proposal is to organize and apply knowledge and techniques that already exist, for social purposes, as well as to develop new knowledge as a basis for public action.

The idea of directing and applying science and technology for specific social ends rests on an entirely different premise than the idea of supporting the development of scientific disciplines through the project system, or of securing information through the project system for use in the realization of an agency's mission. The basic premises of the project system are that science should be supported as a self-regulating system because of the long-range value of science to human affairs. In this system, scientists should make the decisions on the research that is supported.

The basic premise in the movement to develop and apply science to social needs is that science is only one component of a more general system which also includes social, economic, and political factors.

The project system is based largely on a model of science which emphasizes concepts of specialization, and the development of science through specialized, discrete inquiries. The movement to apply science to social needs is based on a model of science as one element of a more general process involving engineers, natural scientists, social scientists, and others. The project system is well suited to the support of science as a series of discrete inquiries, but is not well suited to the support of science in a more general context.

In these terms, there are two implications of the movement to apply science more extensively for the funding of research conducted in universities. The first implication is a movement away from the project system towards more general methods of support which emphasize the engineering, natural science, and social science aspects of one coherent inquiry. The second implication is a decline of the influence of the natural scientist in the distribution of funds and a relative increase on the influence of engineers, social scientists, and others.

The argument advanced here is that a sharp distinction should be made between the support of academic research as a means to developing various disciplines, and the support of research for other purposes, whether educational, economic, or social ones. At the present time there is no alternative system to the project system for supporting research for ends other than the advancement of science, although various potential components of such a system exists. In the concluding section of this study it will be argued that an alternative system should be developed, a system characterized by concerted programming and planning at the federal level and planning among institutions, on a regional basis, at the local level, and a system characterized by direct support of institutions as distinguished from individual investigators.

The Prospects for the Development of a New Research Funding System

According to the argument of this study, four major demands have been made on the federal academic research system in the 1960's: (1) the demand for responsibility in the administration of funds; (2) the demand for equity in the distribution of funds; (3) the demand for the use of educational criteria in the administration of funds; and (4) the demand for greater efforts to apply science to the satisfaction of human needs. Congress in the 1960's has played an important role in the expression of these demands, but has moved slowly towards meeting them through legislation. The President's Memoranda are at best a limited response to these demands. They are only partially addressed to the equity question, the question of the use of educational criteria, and the question of applying science more extensively to national problems. In essence, the Memoranda are designed to preserve the existing system, and extend the capability of selected institutions to participate in the present system.

At the same time, a number of programs of a number of agencies are designed to provide research and research-related funds to universities and colleges on a different basis than the basis of scientific merit applied in the project system. The Department of Commerce's State Technical Services Program, the National Aeronautics and Space Administration's Technology Utilization Program, and the Office of Education's public service program under Title I of the Higher Education Act of 1965 are examples of such programs. However, these programs for the most part are not programs for research *per se*, although the activities under them may include a research component.

These programs, and the persistence of the demands analyzed in this study, raise the possibility of the creation of a new system for the funding of university and college activities, including but not limited to research. While such a system could take many forms, there are at least three particularly strong possibilities.

The first possibility is for a continuing effort to patch up inadequacies in the present system through a proliferation of new special purpose programs either in the name of "research" or in the name of "science development." The position taken in this study is that this is undesirable for two reasons. First, there already are from one- to two hundred programs of various kinds.[1] A proliferation of new, special purpose programs would only further confuse what is already universally recognized as a confusing situation. While some pluralism in the funding of higher education processes may be desirable, the constant creation of new programs makes it difficult for one agency to know what other agencies are going, and even more difficult for universities and colleges to keep track of available sources of funds, and shifts in the policies, procedures, and personnel of the agencies. Second, the creation of new programs in the name of "research" and "science education" might serve to further confuse the issue of the support of research as a means to advancing science, and the support of research and related programs as a means to other ends.

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[1]See U.S. Congress, House, Committee on Science and Astronautics, <u>The Federal Government and Higher Education: Contract, Grant, and Loan Programs to Institutions and Individuals</u>, Report of the Subcommittee on Science, Research, and Development, 90th Cong., 1st Sess., 1967.

The second possibility is for outright aid to universities and colleges for operating expenses through providing institutions with federal funds as a percentage of the non-federal funds received by institutions or through some similar means. This type of aid could be weighted in favor of poorer institutions, and would be particularly useful to private institutions that do not have access to substantial state funds. This possibility has disadvantages. The first is that it is at variance with the long-standing tradition of the independence of private institutions from governmental support and control. While the position may not be warranted, the position of the Association of American Universities, an association of forty of the major universities in the United States, is typical of the tradition:

> The Association of American Universities favors the continuation of a policy of selective rather than general, support. It believes that programs of general operating support of universities by the Federal Government would eventually lead to an erosion of the independence and diversity of our institutions of higher education, and transfer a substantial influence on university academic programs from the institutions themselves

> to Government agencies. A program of selective Federal participation can contribute to the strength and independence of institutions of higher education and enable them better to pursue their ideals of excellence and their objective of public service. Such a program can be broadened and yet remain selective.[1]

The second disadvantage of this proposal is that it raises possible problems under the prohibition of the First Amendment of the U.S. Constitution of laws "affecting an establishment of religion, or preventing the free exercise thereof." The possible unconstitutionality of outright aid to church-related institutions could not only raise serious political problems about the enactment of any general aid provision, but also raise serious problems about the use of funds for religious purposes, even if held to be constitutional. The third disadvantage of this possibility is that it might encourage the proliferation of small institutions and thus contribute to a further dispersion of resources where a degree of concentration might be desirable.[2]

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[1] House, Committee on Science and Astronautics, "Statement of Federal Relations of the Association of American Universities," Government and Science, 1964: Distribution of Federal Research Funds and Indirect Costs re Federal Grants, Hearings, 88th Cong., 2d Sess., 1964, p. 764.

[2] For a further discussion of these points, see Harris, Higher Education: Resources and Finance, Chap. 23, pp. 309-25.

Despite these and similar problems raised by outright aid, the position taken here is that outright aid may be the best long term answer to the substantial variations in the ability and willingness of states to assist both public and private higher education, and the substantial pressures on many institutions as a result of rising enrollments and other factors.[1]

From the administrative viewpoint, outright block grants would minimize the difficulties of keeping track of agency programs, of administering substantial numbers of programs, of trying to coordinate a large number of programs into a meaningful pattern, and of adopting national criteria to diverse local conditions. Even should outright grants for operating expenses be made, however, it is unlikely that all of the basic problems integral to federal funding of research would be resolved.

[1]In general, see Dexter M. Keezer (ed.)., Financing Higher Education (New York: McGraw-Hill, 1959), and U.S. Department of Health, Education, and Welfare, Office of Education, Economics of Higher Education (Washington: U.S. Government Printing Office, 1962). For an analysis of state policies on higher education, see Harris, Higher Education: Resources and Finance, especially Chap. 25, "Some Aspects of Differentials in Higher Education Among States," pp. 336-58; Chap. 26, "Higher Education: Burden, Capacity to Finance, Effort, and Achievement, State by State," pp. 361-76, and Chap. 27, "Differences Among States: Details for 48 States," pp. 377-420.

The third possibility, and the possibility urged as the conclusion of this study, is the development of a system of funding research and related activities on a regional basis. The existing research funding system, the project system with its supplementary programs, should continue to be operated on a merit basis. The pressures for changes in the system should be met by the development of a different system designed to take into account the educational, economic, and social needs of states and regions. The development of such a system would require planning at both the national and local level. At the national level it would require some agreement among agencies on the various roles of respective agencies in providing funds to given areas, through four basic kinds of programs: (1) programs for the construction of major facilities, such as accelerators, that have a potentially great impact in both the economic and educational development of a state and a multi-state area; (2) programs of an institutional development character, such as the Department of Defense's new Project Themis, the National Science

Foundation's University Development and College Development programs, the National Aeronautical and Space Administration's Sustaining University Program, and the Health Science's Advancement Awards of the National Institutes of Health; (3) programs designed to apply science to social needs, such as NASA's technology transfer program and the industrial extension services program of the Department of Commerce, and (4) Office of Education and perhaps National Science Foundation programs explicitly designed to assist under-developed regions, without reference to potential for excellence.

The evidence suggests that the location of major facilities may be even more important to the educational and economic development of states and regions in the future than it has been in the past.[1] The criteria for the site for the AEC's 200-Bev accelerator included such factors as the availability of 3,000 acres of suitable land, access to substantial power and water, and proximity to an industrial and educational center, and a major airport.[2]

[1]For one study that in part is concerned with the question of the effect of federal research facilities in a geographic area, see William G. Pollard, Atomic Energy and Southern Science (Oak Ridge: Oak Ridge Associated Universities, 1966). For a discussion of "big science" see Alvin Wienberg, Reflections on Big Science (Cambridge: M.I.T. Press, 1967).

[2]See Daniel S. Greenberg, "NAS to Study Accelerator Site," Science, CXLVIII, No. 3671 (May 7, 1965), 775.

These criteria could have been extended to include a consideration of other federal research facilities, and it has often been argued that:

> From the economic and social point of view, however, and perhaps even from the longer run scientific point of view, there is a strong case for encouraging the development of scientific research centers in the more depressed and lower income sections of the country, as a means of raising the economic and social level of the population in those areas.[1]

Whatever the subtleties and intricacies of the politics of facility location in the past, the selection process for the 200-Bev accelerator, conducted for the most part by the National Academy of Sciences, indicates that the location of major facilities can be integrated into a coherent policy to develop the academic research and educational capacities of various regions in the country.

The case for integration of science development programs of various agencies into a more comprehensive regional policy is particularly strong, because an indiscriminate selection of one institution by one agency without reference to the activities of other agencies

[1] Johnson, "Federal Support of Basic Research: Some Economic Issues," in National Academy of Sciences, <u>Basic Research and National Goals</u>, p. 140.

could simply be self-defeating. The ultimate effect of having many institutions receive substantial amounts of science development funds would simply be to bid up the price of first-class researchers. Finally, programs designed to apply science to social needs, and educational programs explicitly designed to help institutions in the less developed areas, could be designed to allocate funds on the basis of need to states and regions which did not receive assistance through facility location and science development programs.

The second major component of this regional development plan is the systematic assessment of the capabilities and potentialities of colleges and universities by state and region, and the development of a plan for the growth of institutions in a manner and a direction suitable to the diversity of their strengths, weaknesses, and objectives. Such evaluations and plans should be carried out by the institutions themselves in conjunction with state and regional educational associations, perhaps with the assistance of the American Council on Education.

On the basis of such plans, federal agencies might be able to work out a method of recognizing some division of labor among the institutions of given states and regions.

It is becoming increasingly evident that very few institutions, at least in any immediate sense, can or should aspire to the total institutional excellence and comprehensibility of Harvard and similar institutions. Limitations on manpower, money, and other resources make this prohibitive.[1] On the other hand, all institutions, including liberal arts colleges, may have the potential for developing strength of a nature and in subject areas appropriate to their purposes. Furthermore, the educational and research needs of areas differ, and educational and research strength appropriate to these differences should be developed. Federal funds for research and related purposes could contribute to the development of diversity, rather than of uniformity, if allocated at least in part on the basis of some planning. Through more effective coordination at the federal level and

[1] On this point, see Saunders MacLane, "Leadership and Quality in Science," in _ibid_., pp. 189-202.

more extensive planning at the state and regional level, a more effective linkage between agencies and institutions could be established, to the mutual benefit of both. At the same time, agencies could continue to fund research strictly on the basis of merit through the project system, as they consider it necessary and appropriate to do so.

This idea, of course, has a basic drawback: it is contrary to the policies, politics, and practices of both the agencies and universities and colleges in the past. There has been very little coordination of agency research funding activities, and very little concerted effort by institutions to help themselves as a group. Some incentives are necessary to both the agencies and institutions to induce them to cooperate in the development of a regional funding system. As an initial step, Congress should enact legislation authorizing the Office of Science and Technology and the Office of Education to undertake feasibility studies to determine whether some system of planning is possible.

The basic rationale of this plan is that federal policies should be adjusted to recognize that universities and colleges are regional resources for educational, economic, and social purposes. The project system has been oriented too heavily to the idea that a university is a supermarket where various kinds of goods are sold. It is generally recognized that some kind of change in emphasis is necessary, and a regional funding system along the lines indicated might help to bring about this change in emphasis.

Summary and Conclusion

The purpose of this study has been to examine the policies and procedures used by federal agencies in funding academic research, and to assess the implication of President Johnson's Memoranda of September 13 and 14, 1965, for the development of these policies and procedures. This study has argued that the academic research funding system has been subjected to four major demands in the 1960's, the demand for responsibility in the administration of funds, the demand for equity in the distribution of funds, the demand for the use of educational criteria in the administration of funds, and the demand for an increase in efforts to apply science to social needs. It is concluded that the President's Memoranda indicate the further recognition of institutions, as institutions, as the proper recipients of funds. It is further concluded that the project system should be retained in the primary method of funding research for the advancement of science and the realization of agency missions, but that a new funding system based on regional considerations should be developed. Towards this end Congress should enact legislation to authorize the Office of Science and Technology to study the feasibility of agency coordination of non-project programs on the one hand, and institutional planning on a regional basis on the other.

C O P Y

APPENDIX

The White House,
Washington, September 13, 1965

Memorandum to the heads of departments and agencies.

Subject: Strengthening academic capability for science throughout the country.

A strong and vital educational system is an essential part of the Great Society. In building our national educational system, we must bear in mind all of the parts, and all of the levels--from Head Start for preschool children to the most advanced university levels. At the apex of this educational pyramid, resting on the essential foundation provided for the lower levels, is the vital top segment where education and research become inseparable. The Federal Government has supported academic research in agriculture for over a half century and in the physical sciences, life sciences, and engineering since World War II; the returns on this national investment have been immense.

Of the $15 billion which the Federal Government is spending in research and development activities this year, $1.3, or about 9 percent, is spent in universities. The $1.3 billion, which includes only Federal research grants and contracts, accounts for about two-thirds of the total research expenditures of our American colleges and universities. Over 25,000 graduate students in engineering, mathematics, physical and life sciences are supported indirectly by employment under these research grants and contracts. Plainly the Federal expenditures have a major effect on the development of our higher educational system.

The strength of the research and development programs of the major agencies, and hence their ability to meet national needs, depends heavily upon the total strength of our university system. Research supported to further agency missons should be administered not only with a view to producing specific results, but also with a view to strengthening academic institutions and increasing the number of institutions capable of performing research of high quality.

The functions of the Federal agencies in relation to the strengthening of academic institutions are as follows:

(a) The National Science Foundation continues to have responsibility for augmenting the research capabilities of academic institutions in all fields of science through the support of basic research and research facilities and through measures for improving the quality of education in the sciences;

(b) The Department of Health, Education, and Welfare will contribute to the overall development of colleges and universities and to the development of health professional schools, particularly through programs of the Office of Education and the Public Health Service.

(c) All Federal agencies with substantial research and development programs have an interest and need to develop academic capabilities for research and scientific education as a part of their research missions.

To the fullest extent compatible with their primary interests in specific fields of science, their basic statutes, and their needs for research results in high quality, all Federal agencies should act so as to--

(a) Encourage the maintenance of outstanding quality in science and science education in those universities where it exists;

(b) Provide research funds to academic institutions under conditions affording them the opportunity to improve and extend their programs for research and science education and to develop the potentialities for high quality research of groups and individuals, including capable younger faculty members;

(c) Contribute to the improvement of potentially strong universities through measures such as--

Giving consideration, where research capability of comparable quality exists, to awarding grants and contracts to institutions not now heavily engaged in Federal research programs;

Assisting such institutions or parts of institutions in strengthening themselves while performing research relevant to agency missions, by such means as establishing university-administered programs in specialized areas relevant to the missions of the agencies.

Funds for these purposes should be provided on a scale and under conditions appropriate to the mission of an agency and in accordance with any governmentwide policy guidelines which may be established.

Departments and agencies should carefully assess the degree to which and the manner in which their existing programs support this policy, and, when indicated, should use a larger proportion of their research funds in accordance with the intent of the policy. The means for attaining this objective will be determined by each department and agency. In carrying out the policy, the various Federal agencies supporting research at a university should act in concert to a greater degree in making decisions, so as to make the university better able to meet the collective needs of the agencies and to make the Federal support most effective in strengthening the university.

My Special Assistant for Science and Technology, Dr. Donald Hornig, with the help of the Federal Council for Science and Technology, will follow the response of the departments and agencies to this policy. I have asked him to obtain monthly progress reports and submit them to me.

LYNDON B. JOHNSON.

[For immediate release, September 14, 1965]

OFFICE OF THE WHITE HOUSE PRESS SECRETARY

THE WHITE HOUSE

STATEMENT OF THE PRESIDENT TO THE CABINET ON STRENGTHENING THE ACADEMIC CAPABILITY FOR SCIENCE THROUGHOUT THE NATION

Throughout the postwar years, it has been my abiding and actively supported conviction that the policies of this Nation in support of the advance of science would have a decisive role in determining the extent to which we fulfill our potential as a Nation, and a free society.

On occasion, during these years, there have appeared attitudes almost medieval in their myopia toward the meaning and promise of the growth of human knowledge. Happily, these attitudes have not prevailed and our national policies have been guided by reason, light, and faith in the future of man. As a result, American science today leads the world--free, unfettered, and devoted to the ends of bettering the condition of man in every land.

I say this, by way of preface, because I am proud of the part I have been privileged to play--in the Congress and as Vice President--in opening the doors through which we have moved to some of our most significant scientific gains. Now, in this office, I am determined that we shall marshal our resources and our wisdom to the fullest to assure the continuing strength and leadership of American science and to apply the information yielded by its inquiry to the problems which confront our society and our purposes in the world.

Our policies and attitudes in regard to science cannot satisfactorily be related solely to achievement of goals and ends we set for our research. Our vision in this regard is limited at best. We must, I believe, devote ourselves purposefully to developing and diffusing--through the Nation--a strong and solid scientific capability, especially in our many centers of advanced education. Our future must rest upon diversity of inquiry as well as the universality of capability.

This is very much a concern and a responsibility of the Federal Government and all the departments and agencies of the executive branch.

Today the Federal Government is spending $15 billion annually on research and development activities. Nine percent of this--$1.3 billion--is being spent in our universities on research grants and contracts. Additional sums are spent for educational purposes such as fellowship or training grants and the programs provided by the Higher Education Facilities Act or the National Defense Education Act.

The impact of these Federal funds is significant. They account for about two-thirds of the total research expenditures of colleges and universities. The manner in which such funds are spent clearly has a most important effect upon advanced education in this country and upon the future of our Nation's universities.

Almost all of the Federal research money is provided to produce results that are needed now and in the future to achieve our many national goals in health, in defense, in space, in agriculture and so on. Of the total provided to universities, 34 percent comes from the National Institutes of Health, 23 percent from the Department of Defense, 9 percent from NASA, 6 percent from the AEC, and 4 percent from Agriculture. Only 13 percent is provided by the National Science Foundation, the only agency which supports science and science education as such.

The purpose of the new policy statement I am issuing today is to insure that our programs for Federal support of research in colleges and universities contribute more to the long-run strengthening of the universities and colleges so that these institutions can best serve the Nation in the years ahead.

At present, one-half of the Federal expenditures for research go to 20 major institutions, most of which were strong before the advent of Federal research funds. During the period of increasing Federal support since World War II, the number of institutions carrying out research and providing advanced education has grown impressively. Strong centers have developed in areas which were previously not well served.

It is a particular purpose of this policy to accelerate this beneficial trend since the funds are still concentrated in too few institutions in too few areas of the country. We want to find excellence and build it up wherever it is found so that creative centers of excellence may grow in every part of the Nation.

Under this policy more support will be provided under terms which give the university and the investigator wider scope for inquiry, as contrasted with highly specific narrowly defined projects. These and many more actions will increase the capacity of our universities to produce well-trained scientists and to serve as a source of the ideas on which our national welfare depends.

By adopting this policy, I am asking each agency and department with major research responsibilities to reexamine its practices in the financing of research. I want to be sure that, consistent with agency missions and objectives, all practical measures are taken to strengthen the institutions where research now goes on, and to help additional institutions to become more effective centers for teaching and research.

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